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2000 Evaluation of 4VWX Herring

Stephenson, R.L., M.J. Power, K.J. Clark, G.D. Melvin, F.J. Fife, T. Scheidl, C.L. Waters and S. Arsenault.

Marine Fish Division
Maritimes Region, Science Branch
Biological Station
531 Brandy Cove Road
St. Andrews, New Brunswick, E5B 2L9

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Abstract

Fishery, sampling and research results were compiled and used to evaluate the status of herring in the 4VWX area. Spawning stock biomass (SSB) was estimated from acoustic surveys of spawning grounds to be about 500,000t, similar to the previous two years. Age composition has expanded in recent years but the population still contains a small fraction of fish older than the 1992 year-class (age 7). Large amounts of spawning fish were documented on German Bank but fewer herring were recorded in Scots Bay and on Trinity Ledge spawning areas than in recent years and spawning was again absent on the Seal Island grounds.

The 1999 herring fishery on the Scotian Shelf Banks landed 12,840t, higher than in 1998 but lower than in 1997. The July bottom trawl survey continued to indicate a general increase in abundance and widespread distribution of herring on the banks west of Sable Island. Herring were also prevalent in the Cuban silver hake fishery which took place on the shelf edge.

Changes to management and recent research efforts have improved the knowledge of the fishery in four of the south coastal Nova Scotia spawning areas, but there remains a problem of lack of biological and fishery information for much of this component. There is continued concern for the status of the Bras d'Or Lakes spawning herring.

Landings from the traditional New Brunswick weir and shutoff fishery were lower than the long-term average. These fish are considered to be a mixture originating primarily from Subarea 5.

Résumé

On a compilé les résultats de la pêche, de l'échantillonnage et de la recherche pour évaluer l'état des stocks de harengs dans la zone 4VWX. L'estimation de la biomasse du stock reproducteur (SSB «Spawning Stock Biomass»), tirée de relevés acoustiques des frayères, se chiffre à environ 500 000 t, ce qui équivaut à la SSB des deux dernières années. La composition par âge s'est étendue ces dernières années, mais la population contient toujours une petite fraction de poissons d'une classe d'âge antérieure à celle de 1992 (âgés de 7 ans). D'importantes quantités de poissons frayant ont été relevées sur le banc German, mais dans les zones de frai de Scots Bay et Trinity Ledge on a dénombré moins de harengs qu'au cours des dernières années, et les aires de Sea Island étaient une fois de plus désertes.

En 1999, les débarquements du hareng sur les bancs du plateau néo-écossais a atteint 12 840 t de plus qu'en 1998, mais étaient inférieurs à ceux de 1997. En juillet, le relevé au chalut de fond a continué d'indiquer une augmentation générale de l'abondance et une distribution étendue du hareng sur les bancs ouest de l'île de Sable. On a également trouvé des harengs en grande quantité dans les captures de merlu argenté cubain qui ont eu lieu le long de l'accore du plateau.

Grâce aux changements apportés à la gestion et aux efforts de recherche fournis récemment, on a une meilleure connaissance de la pêche dans quatre zones de frai, situées au sud de la côte de la Nouvelle-Écosse, mais on manque encore de renseignements biologiques et halieutiques sur une grande partie de ce secteur. L'état des géniteurs de harengs adultes de Bras d'Or Lakes continue d'être préoccupant.

Les débarquements provenant de la pêche traditionnelle à la bordigue, au Nouveau-Brunswick, est inférieure à la moyenne à long terme. Le poisson à cet endroit est formé d'un mélange provenant surtout de la sous-zone 5.

2000 Evaluation of 4VWX Herring

1) Background and Context

1.1 Objectives and Management

The 1999-2001 Scotia-Fundy Herring Integrated Fisheries Management Plan (DFO 1999a) sets out principles, conditions, and management measures for the 4VWX herring fisheries. The main principle stated in this plan is "*the conservation of the herring resource and the preservation of all of its spawning components*".

Specific conservation objectives were developed and reviewed in 1997 (Sinclair 1997), and the following three objectives appear in the plan:

1. To maintain the reproductive capacity of herring in each management unit:

- persistence of all spawning components in the management unit;
- maintenance of biomass of each spawning component above a minimum threshold;
- maintenance of a broad age composition for each spawning component; and
- maintenance of a long spawning period for each spawning component.

2. To prevent growth overfishing:

- continue to strive for fishing mortality below $F_{0.1}$.

3. To maintain ecosystem integrity/ ecological relationships ("ecosystem balance").

- specific parameters have yet to be defined.

An "in-season" management process, first implemented in the southwest Nova Scotia fishery during 1995 (DFO 1997, Stephenson et al. 1996,1999a) continued to be used widely within the 4VWX management area. The approach encouraged surveying using the commercial fleet under scientific direction prior to fishing to ensure that effort was distributed appropriately among various components of the stock (particularly among spawning components) according to the relative size and current state of each component. The use of this approach in recent years has improved data collection and enabled modifications to management decisions to be made with the involvement of participants and on the basis of up-to-date information.

1.2 Attributes of Stock Status and Summary of Stock Status Indicators

Within the last year there has been a move to summarize a range of 'stock indicators' in groundfish stock status reports (DFO 1999b). This is in keeping with a move toward consideration of a wider set of indicators and to define criteria relevant to thresholds within a precautionary approach.

There is an established history of looking at a broad range of indicators in 4VWX and 5Z herring (Appendix I). In 1995, for example, a proposed framework for decision-making in the re-emerging Georges Bank herring fishery contained a table of positive, negative and neutral values for a number of biological and survey parameters (Melvin et al 1995). At the same time, a checklist of positive and negative biological attributes was produced to assist in within-season decision making in the 4WX herring fishery. These considerations were used to evaluate the overall stock status and there was an attempt to summarize these for the various parts of the fishery in tabular form (Stephenson et al 1996; DFO 1997).

Since that time, there has been an attempt to define and quantify relevant criteria and to refer to relevant attributes in the assessment and during ongoing in-season management:

- A review of conservation objectives undertaken in 1997 (Sinclair 1997), led to definition of three objectives (see previous section) and to further definition of criteria related to spawning areas (DFO 1999c):

- The location and timing of major spawning areas is known from historical fishing records and this has been used to define the times and locations of surveys which will give year-to-year records of biomass on each spawning ground (Melvin and Power 1999).

- Age composition has been related to the expected distribution under F0.1 fishing and constant average recruitment (Fig. 1).

- Attributes relating to the 'normal' distribution and fishing patterns have been derived in recent years from fleet activity reports that summarize industry information (Paul 1998). Observations in recent years have indicated some anomalies in herring behavior, distribution and condition (fat content), apparently coincident with environmental (temperature) conditions (Harris and Stephenson 1999, Stephenson et al 1999b).

Negative and mixed signals in recent years have been used as the basis for restraint in establishing the TAC and in management of the fishery. Effort has been made to compile relevant information from areas that have received less

research effort and are less well documented, particularly the coastal Nova Scotia (Clark et al 1999) and Scotian Shelf (Harris and Stephenson 1999) spawning components (Fig. 2).

While further definition is required, the following table format of attributes and thresholds are suggested:

Attribute/ Indicator Type	Source	Thresholds/reference	Observation or trend	Interpretation/ status
Primary				
Spawning locations	Acoustic surveys and fishery info	Spawning in all key locations		Prime indicators of current stock status. Objective is to maintain spawning at all locations and over full run timing.
Spawning time	Fishery info and surveys	Spawning throughout full (usual) period		
Spawning: relative amount (SSB)	Acoustic surveys	Min SSB for each spawning area		
Age structure	Biological sampling	Balanced/expected age distribution		Indicates impact of recent fishery (age composition has been reduced during periods of high fishing mortality). Objective is to maintain a broad age composition.
Recruitment	Assessment			Indicates expected future stock status
Fishing mortality	Assessment	F0.1		
Larvae: abundance and distribution	Surveys	Presence of larvae confirms successful spawning. Abundance of larvae in reference to historical mean.		
Scotian Shelf Distribution and abundance	July Survey	Ref distribution and catch rate		
Secondary				
Non-spawning distribution	Fishery information	Presence of historic feeding and overwintering aggregations		
Physiology/condition:				
Maturity at age	Biological sampling	Ref Maturity at age		
Growth	Biological sampling	Ref mean length/wt at age		
Fat content	Industry records	Fat content late 1990's		
Auxiliary				
Environmental cond (temperature)	Industry and DFO data	Cold (and warm) anomolies		
Herring behaviour	Industry observations	Usual behaviour		
Dependent predators (whales)	Industry observations	Distribution of humpback and finback whales		

2) SW Nova Scotia/Bay of Fundy Spawning Component (SWNS/BOF)

2.1 The Fishery

The herring fishing areas as defined by groupings of 10 mile square boxes (= 10 minute squares of latitude and longitude) are shown in Figure 3 and the various fishing locations or grounds mentioned in this document are shown in Figures 4 and 5. The 1999 TAC for this component was established at 105,000t, an increase from 90,000t in the previous year (Fig. 6). Eighty percent of the TAC was allocated to the mobile gear sector and 20% to the fixed gear sector in the usual manner (DFO 1999a). Four thousand tonnes of the mobile gear sector quota (100t per license) were held back until the vessels contributed to surveying.

Total landings from the SWNS/BOF spawning component in 1999 (77,552t) were similar to those in 1998 (78,139t) (Tables 1 and 2). Landings by the purse seine sector (70,430t) were approximately 1,000t lower than in 1998. Landings by the gillnet sector (1,660t) were 25% lower than the previous year. Landings from Nova Scotia weirs (5,461t) were 20% higher than in 1998. Reduced landings in the gillnet sector, and failure to catch the entire quota were considered to be primarily the result of several factors. These include the distribution of quota in relation to market in the purse seine sector, reduced roe market for gillnet sector, quota saved to end of season and lost due to bad weather and fish size in relation to markets.

The in-season management approach, involving ongoing discussion and review of the fishery continued in 1999. Again, fishing on most spawning aggregations operated under a "survey, assess then fish" protocol, in which spawning aggregations were surveyed and a fraction of the observed biomass was made available to the fishery.

The distribution of herring as reflected by monthly fishery catches was as expected and similar to periods when the biomass was at moderate to high levels (Fig. 7). The largest purse seine fisheries occurred on German Bank, off Long Island, N.S. and around Grand Manan on summer feeding fish in the vicinity of Gannet-Dry Ledge (Tables 3a and 3b; Fig. 3). The gillnet fishery was reduced from recent years in June on the Spectacle Buoy area and in August and Sept. on Trinity Ledge (Fig. 8). Herring were found on the usual summer feeding and pre-spawning areas, but were absent from the Seal Island spawning ground and less abundant than historically on Trinity Ledge, Spectacle Buoy and perhaps Scots Bay spawning grounds (Appendix 2). As has been the case for several years, there was only a limited fishery for herring during the winter months in Chedabucto Bay, where during the 1970's and 1980's a larger fishery took place on large over-wintering aggregations.

2.2 Resource Status

Acoustic Surveys

Acoustic surveys were undertaken on major spawning areas and some of the major fishing areas using acoustic equipment on commercial vessels, (supplemented upon occasion by research vessel). Sonars and sounders of the purse seine fleet, and sounders of the gillnet fleet were used to document the number, location and approximate size of herring schools. Six acoustic recording devices (five permanently aboard purse seiners, and one mobile unit used on purse seiners and gillnet vessels) allowed the logging of quantitative records for later analysis from "structured surveys" and during many fishing trips (Appendix 2: Table 1). Biomass estimates were made using standard target strength relationships (Melvin et al 1998).

In spite of a proposed survey plan (Melvin and Power 1999), and a holdback of quota (100t per license) to encourage participation, there was incomplete coverage of the spawning grounds. There were several contributing factors, including bad weather on scheduled survey nights and resistance among some fleet members to participate in or complete surveys. Acoustic surveys from the spawning grounds documented approximately 505,700t of spawning herring (Melvin et al 2000). Due to the incomplete coverage, there remains the problem of direct comparison of surveys from year to year (Table 4).

The evaluation of stock status in this area relies on the spawning stock biomass estimates derived from industry acoustic surveys. In recent assessments, results from acoustic surveys have been used as estimates of minimum spawning stock biomass. Uncertainty may arise from assumptions concerning the duration of herring on spawning grounds, target strength estimates and the spatial coverage of surveys in relation to the extent of spawning.

Sampling and Catch at Age

Biological sampling continued to improve with increased involvement of the fishing industry in sample collection. The distribution of sampling effort is shown in Fig. 9. Table 5 shows sampling by geartype and month and the increasing contribution of the fishing industry is documented in Table 6.

The catch at age was constructed, for the first time using the 'Catch at Age' application (version 6.23) which is a Marine Fish Division windows program for computing catch at age statistics as part of the stock assessment process. The catch at age statistics are calculated from length frequency and age length key samples. The various forms that make up Catch at Age are used to group or combine the Age Length Keys, group or combine the Length Frequencies and then apply Age Length Keys to Length Frequencies to produce Catch at Age statistics. Data files used by 'Catch at Age' are created with the 'Catchfrm' application. Catchfrm is used to select fish sample data from the Pelagic samples database. Data is selected from the specified databases with selection criteria provided via the Catchfrm forms.

The length weight relationships which are also required as input to the 'Catch at Age' application were calculated using the FORTRAN program HERNLW as in the past.

Results from the 'Catch at Age' application were compared in detail with the previously used FORTRAN program HERNAG and some minor differences were found. These were a result of the need to do a 2% adjustment for the shrinkage due to freezing on the length measurements for frozen samples (Hunt et al. 1986). These minor corrections, made after the Regional Assessment Process (RAP) meetings and the release of the final Stock Status Report (DFO 2000), are reflected in this document.

In 1999 the 1996 year-class (age 3) dominated the catch by number, as it did in 1998 (Fig. 10a, Table 7) while the 1994 year-class (age 5) was dominant by weight. The 1992 and 1993 year-classes (ages 7 and 6) made up 12% of the catch by number and 24% by weight. The age composition has expanded since 1996 when the fishery relied almost exclusively recruiting year-classes (Fig. 10b). There were, however, few fish older than the 1992 year-class in this component of the stock.

The historic catch at age for the SW Nova Scotia spawning component is shown in Table 8a, 8b and Fig. 11. The targeting of immature fish for the meal fishery is of note in the late sixties as is the tracking of strong year-classes especially those of 1970, 1976 and 1983.

The average weights at age (fishery weighted) are shown in Table 9 and Fig. 12. There seems to be no strong trends over time with consistent year-to-year shifts by age.

Larval Herring Abundance

No larval survey was undertaken in 1999 for this component.

Sequential Population Analysis

The historic development of the stock was illustrated using sequential population analysis (SPA) in which the 1999 spawning stock biomass was set approximately equal to the tonnage observed by acoustic surveys (Figure 13). This demonstrated an increase in spawning stock biomass (Table 10) which is generally agreed to have occurred since 1994. However, there are inconsistencies between the apparently large increase in spawning stock biomass (and reduction in F) (Table 11) in recent years based on the SPA and with what has been documented in the acoustic surveys.

2.3 Summary of Stock Status Indicators – SW Nova Scotia/Bay of Fundy

Attribute/ Indicator Type	Source	Thresholds/reference	Observation/trend	Interpretation/ status
Primary				
Spawning locations	Acoustic surveys and fishery info	Spawning in all key locations	Spawning documented at German Bank, Scots Bay and Trinity Ledge, but limited at Spectacle Buoy and none on Seal Island	Negative: Spawning absent or reduced in two of five traditional spawning areas
Spawning time	Fishery info and surveys	Spawning throughout full (usual) period	Normal in Scots Bay, Trinity Ledge and German Bank	Positive
Spawning: relative amount (SSB)	Acoustic surveys	Min SSB for each spawning area	Increased survey estimates for German Bank, but lower documented spawning in Scots Bay, Trinity Ledge and Spectacle Buoy	Mixed: Survey coverage incomplete. SSB>500kt. Only German Bank can be demonstrated to be as large as in the previous year.
Age structure	Biological sampling	Balanced/expected age distribution	Age composition continues to improve, but only 12% of numbers are ages 6+ and there are few fish older than age 7	Negative
Recruitment	Assessment	Long term mean	Strong recruitment in the last two years (1998 year-class)	Positive
Fishing mortality	Assessment	F0.1	Current fishing mortality estimated to be <F0.1	Positive
Larvae: abundance and distribution	Surveys	Presence of larvae confirms successful spawning. Abundance of larvae in reference to historical mean.	No survey in 1999 but recent surveys indicate increase from low about 1994.	
Secondary				
Non-spawning distribution	Fishery information	Presence of historic feeding and overwintering aggregations	Herring present on traditional summer feeding grounds. Overwintering aggregation in Chedabucto Bay and at Chebucto Head as in recent years.	Positive
Physiology/condition:				
Maturity at age	Biological sampling	Ref Maturity at age		
Growth	Biological sampling	Ref mean length/wt at age		
Fat content	Industry records	Fat content late 1990's	Reported by processing plants to be normal	Positive
Auxiliary				
Environmental cond. (temperature)	Industry and DFO data	Cold (and warm) anomolies		
Herring behaviour	Industry observations	Usual behaviour	Usual pattern of behaviour	Positive
Dependent predators (whales)	Industry observations	Distribution of humpback and finback whales	Whales observed in large number along Long Island Shore; similar in distribution to early 90's	Positive

2.4 Ecosystem Considerations

Herring is a prominent species in the diets of many other fish, birds and marine mammals, and should be managed with these interactions in mind. At present, a natural mortality rate of 0.2 and maintenance of SSB at moderate to high levels is assumed to account for these interactions.

In the last assessment, there was a preliminary analysis of the distribution of humpback and finback whales (predators of herring) in the month of August, which indicated that there had been fewer animals near the Long Island shore of Nova Scotia from 1995 to 1998 compared to the early 1990's. Reports from the same whale-watching operation (Carl Haycock, BIOS, pers. comm.) indicated that these whales were abundant in the Long Island shore area again in 1999 and that it was reminiscent of the earlier period.

Recent management initiatives to protect spawning components are intended to maintain the spatial and temporal diversity of herring spawning.

2.5 Outlook

Acoustic surveys documented about 500,000t of herring on spawning grounds. As there was incomplete coverage in all areas, this is considered to be a minimum estimate of spawning stock biomass.

Surveys and fishing confirmed the presence of large amounts of herring on German Bank. Fewer herring were recorded in surveys of Scots Bay and Trinity Ledge spawning areas than in previous years. While some of this apparent reduction may have been due to incomplete survey coverage, the SSB observed at Trinity Ledge in recent years remains below historic levels and the apparent reduction in SSB in Scots Bay is cause for some concern. There is also concern over the lack of spawning in the traditional Seal Island area and limited spawning at Spectacle Buoy.

Substantial aggregations of herring were documented outside the spawning areas. The geographic distribution of herring during the summer feeding period was as expected from observations in previous years when the stock was at moderate to high abundance.

Again in 1999 the TAC was not caught, but this is attributed primarily to allocations and market conditions, rather than resource status.

The age composition has improved with the age structure of ages 2 to 5 similar to the long term average (Fig. 1) but only 12% were 6+ and few were older than age 7 (Table 8, Fig. 10). The 1996 year-class was strong as predicted.

The spawning stock biomass from acoustic surveys appears to have increased from the low in 1994 to above 520,000t in 1998 and is now considered to be at least 500,000t (Table 4). Historic development of the fishery was estimated using an untuned SPA that resulted in an SSB in 1999 consistent with the biomass from the acoustic surveys for that year. This analysis indicated a rapid increase in SSB in recent years (Table 10, Fig. 13) and it was disconcerting that this was not reflected in increased recorded SSB from acoustic surveys in 1999 over 1998. This is hypothesized to be due to incomplete survey coverage, however there were more recording units and as much effort put into surveying in 1999 as in 1998. The alternate hypothesis is that the SSB is smaller than 500,000t.

Recent assessments of the SWNS/BOF spawning component suggested that fishing mortality should remain below $F_{0.1}$ (about 20% exploitation rate) for a number of years in order to rebuild spawning stock biomass in all spawning areas and expand age composition. It has been stated that these improvements in stock status will take time, and it would be prudent to continue to fish below $F_{0.1}$. The stock size appears to have increased since 1994, and there has been a substantial contribution to SSB by the large 1996 year-class, but there is

insufficient spawning in several traditional areas and a lack of old fish in the population. Catches similar to those of the past two years (less than 100,000t) and use of the "survey, assess, then fish" protocol on spawning grounds should generate F less than $F_{0.1}$. This scenario should allow continued growth of the stock and further expansion of the age composition.

2.6 Management Considerations

The in-season management approach, which spreads the effort in the fishery spatially and temporally among spawning components, is seen as beneficial in achieving the objectives related to maintaining spawning potential (Stephenson et al 1999a).

The "survey, assess, then fish" protocol is effective in spreading the catch appropriately among spawning components in proportion to their relative size and should be strictly adhered to particularly in Scots Bay and on Trinity Ledge where the 1999 SSB was low.

The 1998 assessment suggested that the portion of surveyed spawning stock biomass taken on the spawning grounds should be reduced below 20% to account for the amount that might be taken in fisheries outside of the spawning season. If all the spawning fish were being surveyed, and if the 20% of each surveyed portion of the spawning component were taken, the protocol could allow disproportionate catch from some spawning areas. At present however, survey coverage is incomplete, and sub-allocations based on the 20% protocol have not usually been taken. While the protocol would be improved by using a percentage less than 20%, this is seen as a minor refinement of a management decision-making procedure which is very valuable as currently used.

Acoustic surveys have become critical to stock status evaluation. It is important that there be continued improvement in coverage and survey design, and attention to developing year-to-year consistency in these surveys. A plan for "structured surveys" has been proposed (Melvin and Power 1999).

Initial results from the tagging program indicate at least some affinity between the winter aggregations off Chebucto Head and the SW Nova Scotia/Bay of Fundy spawning component (Paul 1999; Waters et al 2000). The affinity of these overwintering aggregations will be documented further with expected tag returns in the next few years.

3) Offshore Scotian Shelf Banks Spawning Component

3.1 The Fishery

A foreign fishery during the period 1963-1973 is estimated to have removed as much as 60,000t per year from the offshore Scotian Shelf banks (Table 2) (Stephenson et al 1987). There had been little effort or herring catch after the extension of jurisdiction in 1977 until 1996 when a fishery was initiated by the 4WX purse seine fleet and 11,745t was taken.

The 1999 purse seine fishing activities offshore occurred from May 25 to June 17, a shorter season (24 days) than in the past year (55 days)(Figs. 14 and 15). Landings in 1999 (8,989t) were higher than in 1998 (5,579t), but substantially lower than in 1997 (20,261t). Fishing activity focused primarily on the Patch and Bullpen fishing areas. Early in the season, fish were reported as staying deep and were hard to catch, but by the end of the fishery they were reported to be bunching up and coming to the surface. The early completion of fishing activities in 1999 was related to factors other than availability of fish (including market availability and cost of fishing the offshore banks).

Herring were prevalent as by-catch in the domestic ground trawl fishery (Fig. 16) and in the Cuban silver hake fishery on the Scotian Shelf edge and slope (Fig. 17). A total of 190t of herring were recorded, and the 10% by-catch level for herring was reported to hamper the progress of the silver hake fishery (Table 1, Fig. 17).

The 1993 year-class (age 6) dominated the purse seine catch and this same year-class was also prevalent in the by-catch from the silver hake fishery along with the 1992 year-class (age 7)(Table 12, Fig. 18). In the July bottom trawl survey the 1994 year-class (age 5) was dominant followed by the 1993 year-class. This difference is attributed to the fact that the bottom trawl survey covers a larger area and is undertaken slightly later in the year than the fishery.

3.2 Resource Status

The 1999 offshore banks fishery was dominated both in number and weight by the 1993 year-class (age 6, about 60% by both number and weight). The age structure was consistent with the previous year and was again composed almost exclusively of the 1991 through 1994 year-classes.

Results from the summer bottom trawl survey showed few herring on the Scotian Shelf during the 1970's, increasing amounts during the 1980's and a relatively widespread distribution in recent years (Fig. 19). Offshore herring catches during the 1999 July bottom trawl survey were the highest in the 30-year time series with an average of 226 fish per standard tow (Table 13, Fig. 20). Herring were widely distributed on banks west of Sable Island. Catches in 1999 were widely

distributed and the highest for the 17 year period during which the same vessel and gear have been used. The catch at age for the offshore survey strata areas (Fig. 21) was dominated by the 1994 yearclass (age 4) as in the previous 2 years. The groundfish survey strata used for this analysis (strata 55-78: Fig. 22) extended from 'The Gully', east of Sable Island, to the eastern edge of Browns Bank.

The only survey of 'The Patch' area by members of the purse seine fleet on June 10, 1999 documented a biomass of 22,427t. The DFO research survey in November documented 1,379t on the Patch and 1,556t on Mackenzie Spot.

3.3 Summary of Stock Status Indicators – Offshore Scotian Shelf *Banks*

Type	Attribute/ Indicator	Source	Threshold/reference	Observation or trend	Interpretation/ status
Primary					
Spawning locations	Acoustic surveys and fishery info		Spawning in all key locations	No information	
Spawning time	Fishery info and surveys		Spawning throughout full (usual) period	No information	
Spawning: relative amount (SSB)	Acoustic surveys		Min SSB for each spawning area	No information	
Age structure	Biological sampling		Balanced/expected age distribution		
Recruitment	Assessment			No information	
Fishing mortality	Assessment		F0.1	No information	
Larvae: abundance and distribution	Surveys		Presence of larvae confirms successful spawning. Abundance of larvae in reference to historical mean.	Surveys in 1997 and 1998 confirm spawning on offshore Banks. No new information	
Scotian Shelf Distribution and abundance	July Survey		Ref distribution and catch rate	Widespread distribution and highest abundance in the series	
Secondary					
Non-spawning distribution	Fishery information		Presence of historic feeding and overwintering aggregations	Herring seen as expected on early summer feeding areas of Patch and Bullpen	
Physiology/condition:					
Maturity at age	Biological sampling		Ref Maturity at age		
Growth	Biological sampling		Ref mean length/wt at age		
Fat content	Industry records		Fat content late 1990's		
Auxiliary					
Environmental cond. (temperature)	Industry and DFO data		Cold (and warm) anomolies		
Herring behaviour	Industry observations		Usual behaviour		
Dependent predators (whales)	Industry observations		Distribution of humpback and finback whales		

3.4 Outlook

Landings in the foreign fisheries of 13,000t to 60,000t between 1969 and 1973 did not appear to be sustainable.

The initial catch level for 2000 should not exceed the 12,000t reference value used in the recent fishing plans. There continues to be the need for industry surveys to estimate abundance before any extension of the fishery occurs.

3.5 Management Considerations

The fishery in 1999 focused on the Patch and the Bullpen fishing grounds. Since evidence for increased abundance is derived from consideration of the entire

offshore banks area it would be beneficial to spread the fishing effort and survey coverage over a wider area.

There continues to be insufficient documentation of stock size, distribution and spawning behaviour for this component. Industry, Science and Management are encouraged to continue to work together to improve the biological basis for management.

4) Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia Spawning Component

4.1 The Fishery

There has been an increase in the number of active gillnet licenses in recent years. This was the fourth year for a fishery on spawning fish east of Halifax and the third year of gillnet roe fisheries off Little Hope and Glace Bay.

Recorded landings by all gillnet fisheries along the coast of Nova Scotia totalled 7,351t in 1999, an increase of 75% from 1998 (4,192t) and 148% from 1997 (2,965t). Landings in major coastal Nova Scotia gillnet fisheries are shown in Table 14.

4.2 Resource Status

Several aspects of this component and its fishery were documented last year in a questionnaire survey of fishers conducted by DFO Science and the Pelagics Research Council (Clark et al. 1999). This project included the identification of active and historic spawning sites for the Coastal Nova Scotia spawning component (Figure 23). With the implementation of mandatory log records in 1998, the landings in the inshore fishery are being documented with improved accuracy, however, apart from a few areas, there remains insufficient information to evaluate stock status. The major fisheries of this component are discussed below.

East of Halifax

The October roe fishery lasted from September 27 to October 22, 1999 with total landings of 1,620t (Table 14, Figure 24). Gillnets with a mesh of 2¾ inches or greater were used in this fishery.

Three surveys were conducted along the Eastern Shore of Nova Scotia (Table 15). The first survey on the night of October 2 involved 11 boats and documented 20,200t of fish in an area extending from Eastern Passage to Jeddore. The second, conducted during the day on October 4 by the research vessel J.L. Hart, documented 4,700t using the portable acoustic gear. The third

survey on the night of October 10 involved seven boats and documented 9,500t of fish: 7,100t off Eastern Passage and 2,400t off Jeddore. Since the three surveys were within ten days of each other the highest estimate of 20,200t was used.

The Eastern Shore Fishermen's Protective Association made arrangements for a seiner from Cape Breton to tag fish off the Eastern Shore. A total of 1,896 tags were applied with length frequency and detailed samples taken from a purse seiner involved in the tagging operation (Figures 25 and 26). No tags were returned during the fishery. An additional length frequency and detailed sample was collected from the gillnet fishery. Herring in this sample ranged from 29.0 cm to 37.5 cm with a mode at 31.0 cm (Figure 27) and the majority (97%) were stage 6 (Figure 28). Again in 1999 the gillnet fishery was dominated by ages 6 (44% by number, 41% by weight) and 7 (37% by weight, 39% by number)(Table 16, Figure 29).

Little Hope

The fishery occurred in the Little Hope area southwest of Liverpool, N.S., from September 16 to October 14, 1999. A total of 2,919t of herring was landed by gillnet fishers, an increase of one and a half times from 1998 and five times from 1997 (Table 14, Figure 30). Gillnets with a mesh of $2^3/_8$ inches or greater were used in this fishery.

Two surveys of the area were undertaken in 1999 (Table 15). A mapping survey on September 26 documented 6,100t while a survey using the portable acoustic gear on October 3 documented 15,800t. Since these surveys were within ten days of each other, the maximum estimate of 15,800t was used. Two additional surveys were cancelled due to poor weather conditions.

Six length frequency samples and one detailed sample were taken during the 1999 fishery (Figures 31 and 32). The majority of fish were ripe and running (99% maturity stages 5 and 6). Landings were dominated by the 1993 year-class (age 6 – almost half the catch in number and weight), followed by the 1992 year-class (age 7 – 30% by number, 33% by weight)(Table 16, Figure 33).

Glace Bay

The fishery off Glace Bay, Cape Breton lasted from September 3 to October 4, 1999. Gillnets with a mesh of 2¾ inches or greater were used in this fishery. Landings were 1,040t, a decrease of 40% from 1998 due largely to poor market conditions (Table 14, Figure 34). The 1999 fishery occurred mostly on the Red Grounds off Sydney Mines, with some landings further east.

A survey using the portable acoustic gear was scheduled for September 21, 1999 but was cancelled due to adverse weather conditions. Instead a mapping

survey was conducted using a single vessel and 2,000t were documented on the Red Grounds in an area of 5 km² (Table 15).

Four length frequency and four detailed samples were taken during the 1999 fishery (Figures 35 and 36). The majority of the fish (93%) were ripe and running (maturity stages 5 and 6). The 1992 year-class (age 7) was dominant in numbers (54%) and weight (53%), followed by the 1991 and 1993 year-classes (Table 16, Figure 37).

In the July groundfish stratum 442 (Fig. 22) survey covers the area of 4Vn that includes the fall roe fishery off Glace Bay. In 1999, herring catches by number from this stratum were the highest in the past ten years (1,605 herring caught, average of 229 herring per set) and the catches by weight were the highest since 1994 (431 kg, 62 kg per set) (Table 17). These catches were also greater than the overall averages for the 1970s, 1980s and 1990s. It should be noted, however, that there is a great deal of annual variability in the numbers and weights of herring caught in this survey.

Bras d'Or Lakes

In 1998, the spring fishery began March 30 and continued to May 18, with the majority of fishing activity between April 20 and May 1. In 1999, conditions of license were issued April 9 and the spring fishery continued until May 2 with peak landings occurring between April 17 and 25, slightly earlier than 1998. Landings in the spring of 1999 were 31t, a considerable reduction from 1998 (Table 14, Figure 38). This decrease in landings can be attributed largely to the closure of many of the traditional fishing areas and a reduction in the number of fishers involved in the spring fishery. In the past, this fishery has largely been executed close to shore on spawning fish. The closure of the spawning areas forced fishers to move to non-traditional locations where catches were lower (Figure 39).

In 1999, as in the previous year, there was very little ice on the Lakes allowing nets to be set near Groves Point in the St. Andrew's Channel, an area which is often iced over. As a result of the closed areas in the Barra Strait, Baddeck Bay and at Groves Point, the landings from near these traditional areas were considerably reduced and the St. Andrews Channel and the Strait were not occluded by nets. Ten percent of the landings were recorded from Great Bras d'Or Channel, an area which was not commonly fished in the past. This change was again due to the implemention of closed areas in normal fishing locations.

Six surveys were conducted in the Bras d'Or Lakes in 1999 (Table 15). The first mapping survey, conducted February 20th documented an estimated 1,000t of fish but, due to adverse weather conditions, no sample could be taken to verify that these were spring spawning herring. Three mapping and two acoustic surveys were conducted between April 8 and April 15. Since the four surveys in

the Big Lake were within ten days of each other the maximum estimate of the amount of herring seen during the first week of the fishery was 480t. This observed biomass of 480t is considered to be small in relation to the historic size of the recorded catch that peaked at 400t in 1987 (Figure 38).

Only one egg bed survey was conducted during the 1999 spring fishery so the summary of spawning locations was based largely on information provided to DFO Science by fishers, direct observations by DFO Science personnel and the condition of fish in the detailed samples. There was no apparent decrease in the number of spawning locations between 1998 and 1999 and an increase from 1996 and 1997. Spawning was still absent at many of the traditional locations including the St. Peters area and much of West Bay (Figure 40).

Nineteen length frequency and eight detailed samples were collected during the 1999 spring fishery (Figures 41 and 42). The majority of the fish (68%) were ripe and running (maturity stages 5 and 6) with 18% spent and recovering (stages 7 and 8). In 1999 14% of the fish were autumn spawners, a decrease of 2% from 1998. The 1991 year-class (age 8 – 42% by number and weight) was most prevalent followed by the 1992 year-class (age 7 – 30% by number, 27% by weight)(Table 16, Figure 43).

As in previous years, a small herring fishery was conducted in August and September. The landings from this fall fishery were 27t.

4.3 Outlook

Since 1996 there has been pressure to develop the inshore fisheries, especially for roe. The growth of these fisheries often occurs in the absence of knowledge of the current level of fishing pressure or estimates of spawning group status.

In the past, the fixed gear herring fishery in the coastal Nova Scotia spawning component has been largely unrestricted and undocumented. Changes to management and recent research efforts have improved knowledge in some areas, but few of the spawning areas have been studied. The lack of knowledge on the specifics of stock structure, lack of documentation of the historical fishery, and limited survey information preclude evaluation of current fishing mortality. Individual spawning groups within this component are vulnerable to fishing because of their relatively small size and proximity to shore.

As in the past three years, it is recommended that "*no coastal spawning area should have a large effort increase until much more information is available on the state of that spawning group. There should be no new fisheries developed when there is uncertainty regarding stock composition and degree of mixing*" (DFO 1999c).

In 1999 landings from the Little Hope area amounted to 18% of the surveyed biomass and were one and a half times higher than the previous year. Such an increase in landings, in the absence of increased knowledge of fishing mortality, is a concern.

It was noted in 1997, 1998 and 1999 that the status of herring in the Bras d'Or Lakes was cause for concern. This year there have been some signs that indicate that the restrictive management measures are having a positive effect but spawning is still absent from some traditional areas and the observed biomass of 480t is considered low. For the third year it is therefore appropriate to advise that *"Given continued deterioration in signals from the Bras d'Or Lakes fishery it is preferable, from a biological perspective, that no fishing take place on this spawning component"* (DFO 1999c).

4.4 Management Considerations

In coastal Nova Scotia there is no overall quota, and the size and historical performance of various spawning groups are poorly documented. In addition to traditional fisheries for bait and personal use there are new directed roe fisheries on the spawning grounds. The "survey, assess, then fish (<10%)" protocol is considered useful for spawning components that are considered to be healthy and of sufficient size, but is not practical for all coastal spawning groups.

4.5 Summary of Stock Status Indicators – Coastal Nova Scotia

Atribute/ Indicator Type	Source	Thresholds/reference	Observation/trend	Interpretation/ status
Primary				
Spawning locations	Acoustic and mapping surveys and fishery info	Spawning in all key locations	Spawning documented off Glace Bay, the Eastern Shore and Little Hope. Spawning in the Bras d'Or equal to 1996 and greater than 1996 and 1997, but still absent at some traditional locations	**Positive:** off Glace Bay, the Eastern Shore and Little Hope. **Mixed:** Bras d'Or Lakes **Unknown** for many locations along the coast.
Spawning time	Fishery info., surveys and samples	Spawning throughout full (usual) period	Normal off Glace Bay, the Eastern Shore, Little Hope and in the Bras d'Or.	**Positive.**
Spawning: relative amount (SSB)	Acoustic and mapping surveys	Min SSB for each spawning area	Increased survey estimate for the Eastern Shore, similar survey estimate to 1998 for Little Hope. First year of surveys off Glace Bay and in the Bras d'Or.	**Positive:** Eastern Shore and Little Hope. No decline in observed SSB. **Unknown:** Glace Bay **Negative:** Bras d'Or Lakes. Less than 500t documented which is a small amount relative to the known historical size of the catch
Age structure	Biological sampling	Balanced/expected age distribution	No information other than gillnet catches which are influenced largely by gear selectivity	**Unknown.**
Recruitment	Assessment			
Fishing mortality	Assessment	F0.1		
Secondary				
Non-spawning distribution	Fishery information	Presence of historic feeding and overwintering aggregations		
Physiology/condition:				
Maturity at age	Biological sampling	Ref Maturity at age		
Growth	Biological sampling	Ref mean length/wt at age		
Fat content	Industry records	Fat content late 1990's		
Auxiliary				
Environmental cond. (temperature)	Industry and DFO dat	Cold (and warm) anomolies		
Herring behaviour	Industry observations	Usual behaviour		
Dependent predators (whales)	Industry observations	Distribution of humpback and finback whales		

5) SW New Brunswick Migrant Juveniles

The southwest New Brunswick weir and shutoff fishery has relied, for over a century, on the aggregation of large numbers of juvenile (ages 1-3) herring near shore at the mouth of the Bay of Fundy. These have traditionally been considered to be a mixture of juveniles, dominated by fish originating from Subarea 5 spawning components, and have therefore been excluded from the 4WX quota. Mature herring (ages 4+) taken in this fishery are considered to be of 4WX origin.

The number of active weirs and distribution of weirs has decreased over the past decade, due in part to the conversion of sites to aquaculture as well as the

reduction in landings over the past decade in the Passamaquoddy Bay area (Table 18, Figs. 44 and 45). The 1999 catch of 18,644t for N.B. weir and shutoff gears was somewhat lower than that of the previous year (20,091t), and below the 36-year average of about 26,000t (Tables 1 and 2; Fig. 46).

The spatial and temporal distribution of catches were similar to those of recent years (Figs. 44 and 45).

Sampling of this fishery has been extensive (Table 5). The 1999 catch was dominated by the 1996 year-class (age 3) which made up over 40% of the catch by number and by weight (Table 19, Fig. 47). Ages 4+ made up 25% of the weir catch by number.

The recent US management plan (NEFSC 1998) assumes that all of the juvenile herring from this fishery originate from the US "coastal complex" (5Y + 5Z) which is considered to be at high abundance. The assumptions of stock affinity are being investigated in a tagging program that saw 9,700 tags applied to NB weir fish during 1999 (Waters et al 2000).

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Table 1. 4VWX herring fishery landings (t) by month, gear sector and management unit for 1999 (calendar year).

			Month												
	Area	Gear	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
Coastal Nova Scotia (South Shore, Eatern Shore, Cape Breton)	4Vn	Trap					170	384	23						558
		Bras d'Or Gillnet				25	6								31
		Glace Bay Gillnet									1,038	2			1,040
		Other													-
	4W	Eastern Shore Gillnet									470	1,150			1,621
		Trap							-						-
	4X	Little Hope Gillnet									1,392	1,527			2,919
		Trap					-	1		3					4
	4VWX	Misc. Gillnet	-				12	5	-	11	27	19	6		81
		Misc.								1.3					1.3
Coastal Nova Scotia Total						25	189	370	24	16	2,927	2,698	6		6,255
Offshore S.S.	4WX	Offshore P. Seine					2,281	10,287	78						12,646
		Cuban by-catch	18	42	17	8	27	8	0						119
		Bottom Trawl		1	2	2	10	15	18	11	4	5	3	1	71
Offshore S.S. Total			18	43	19	9	2,318	10,310	96	11	4	5	3	1	12,836
S.W. Nova Scotia	4W	Fall/Winter P. Seine											1,235		1,235
	4X	Fall/Winter P. Seine				485						3,841	438		4,764
		Summer P. Seine					2,541	9,148	20,097	8,919	16,890	8,837			64,432
		Gillnet "Stock"					-	252	103	78	1,226				1,660
		N.S. Weirs					2,619	1,776	547	488	31				5,461
S.W. Nova Scotia Total						485	5,161	11,175	20,747	9,485	18,148	10,678	1,673		77,552
Migrant Juveniles	4X	N.B. Weirs					29	541	5,183	9,945	2,487	48			18,234
		N.B. Shutoff							160	170	80				410
Migrant Juveniles Total							29	541	5,343	10,115	2,567	48			18,644

Table 2. Historic series of nominal and adjusted annual landings (t) by major gear components and seasons of the 4WX herring fishery, 1963-1998 (the 1963-73 Offshore Scotian Shelf landings are from Stephenson et al. (1987)).

Year^	4W Winter Purse Seine	4Xs Fall/Winter Purse Seine	4Xqr Summer Purse Seine	4X Summer Gillnet	4Xr Summer Weir	4WX Stock Nominal Landings	4WX Stock Adjusted Landings*	4WX Stock TAC	Non-Stock 4Xs Weir and Shutoff	Offshore Scotian Shelf Banks	Total 4WX Adjusted Landings
1963		6,871	15,093	2,955	5,345	30,264	30,264		29,366	3,000	62,630
1964		15001	24,894	4,053	12,458	57,396	57,396		29,432	2,000	88,828
1965		15,755	54,527	4,091	12,021	86,394	86,394		33,346	6,000	125,740
1966		25,645	112,457	4,413	7,711	150,226	150,226		35,805	2,000	188,031
1967		20,888	117,382	5,398	12,475	156,143	156,741		30,032	1,000	187,773
1968		42,223	133,267	5,884	12,571	193,945	196,362		33,145	18,000	247,507
1969	25,112	13,202	84,525	3,474	10,744	137,057	150,462		26,539	121,000	298,001
1970	27,107	14,749	74,849	5,019	11,706	133,430	190,382		15,840	87,000	293,222
1971	52,535	4,868	35,071	4,607	8,081	105,162	129,101		12,660	28,000	169,761
1972	25,656	32,174	61,158	3,789	6,766	129,543	153,449		32,699	21,000	207,148
1973	8,348	27,322	36,618	5,205	12,492	89,985	122,687		19,935	14,000	156,622
1974	27,044	10,563	76,859	4,285	6,436	125,187	149,670		20,602		170,272
1975	27,030	1,152	79,605	4,995	7,404	120,186	143,897		30,819		174,716
1976	37,196	746	58,395	8,322	5,959	110,618	115,178		29,206		144,384
1977	23,251	1,236	68,538	18,523	5,213	116,761	117,171	109,000	23,487		140,658
1978	17,274	6,519	57,973	6,059	8,057	95,882	114,000	110,000	38,842		152,842
1979	14,073	3,839	25,265	4,363	9,307	56,847	77,500	99,000	37,828		115,328
1980	8,958	1,443	44,986	19,804	2,383	77,574	107,000	65,000	13,525		120,525
1981	18,588	1,368	53,799	11,985	1,966	87,706	137,000	100,000	19,080		156,080
1982	12,275	103	64,344	6,799	1,212	84,733	105,800	80,200	25,963		131,763
1983	8,226	2,157	63,379	8,762	918	83,442	117,400	82,000	11,383		128,783
1984	6,336	5,683	58,354	4,490	2,684	77,547	135,900	80,000	8,698		144,598
1985	8,751	5,419	87,167	5,584	4,062	110,983	165,000	125,000	27,863		192,863
1986	8,414	3,365	56,139	3,533	1,958	73,409	100,000	97,600	27,883		127,883
1987	8,780	5,139	77,706	2,289	4,786	100,700	147,100	126,500	27,320		174,420
1988	8,503	7,876	98,371	695	7,518	124,653	199,600	151,200	33,421		233,021
1989	6,169	5,896	68,089	95	3,308	83,557	97,500	151,200	44,112		141,612
1990	8,316	10,705	77,945	243	4,049	102,627	172,900	151,200	38,778		211,678
1991	17,878	2,024	73,619	538	1,498	97,010	130,800	151,200	24,576		155,376
1992	14,310	1,298	80,807	395	2,227	100,227	136,000	125,000	31,967		167,967
1993	10,731	2,376	81,478	556	2,662	98,464	105,089	151,200	31,573		136,662
1994	9,872	3,174	64,509	339	2,045	80,099	80,099	151,200	22,241		102,340
1995	3,191	7,235	48,481	302	3,049	62,499	62,499	80,000	18,248		80,747
1996	2,049	3,305	42,708	6,340	3,476	58,068	58,068	57,000	15,913	11,745	85,726
1997	1,739	2,926	40,357	6,816	4,019	56,117	56,117	57,000	20,552	20,261	96,930
1998	1,405	1,484	67,433	2,231	4,464	77,027	77,027	90,000	20,091	5,591	102,709
1999	1,235	4,764	64,432	1,660	5,461	77,552	77,552	105,000	18,644	12,646	108,842

^Annual landings by purse seiners are defined for the annual plan period from October 15 of the preceding year to October 14 of the current year.
All landings by other gear types are for the calendar year.

Table 3a. Summary of herring purse seine catches (t) from 1984 to 2000 by year and fishing grounds.

	Year																	
S.W. Nova Grounds	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**Series Total**
Browns Bank			732						86		1,903	1,554	40	14	2,967	1,392		8,688
Chedabucto Bay	490	3,887	4,607	910	4,097	3,369	8,620	10,641		1,325	1,407	2,049	1,759		1,583	1,235		45,980
Gannet,Dry Ledge		5,675	2,187	1,474	14,901	2,010	4,213	6,294	18,527	2,935	2,588	2,693	1,963	4,590	4,489	10,111		84,648
German Bank		15,522	13,346	16,547	18,392	8,087	11,744	23,193	3,235	4,045	9,662	19,549	15,898	13,576	20,698	24,876		218,369
Grand Manan	372	4,989	5,823	4,298	4,440	4,300	5,442	4,225	2,722	783	6,846	5,297	6,005	5,312	15,682	7,901	146	84,582
Long Island		974	3,365	7,499	10,722	21,719	18,484	9,470	3,213	2,814	7,666	7,906	4,385	3,557	12,476	18,184		132,432
Lurcher		476	132		2,928	18	65	151	2,141	1,560	530	382	243	599	57	81		9,362
N.B. Coastal	384	188	621	960	1,031	3,033	2,347	488	992	598	99	1,502	271	1,176	846	1,891	113	16,539
S.W. Grounds		558	1,108	184	181	276	56	521	225	2,961	3,444	6,205	3,035	797	1,143	4,018		24,711
Scots Bay			36	3,822	4,145	6,583	9,003	7,962	7,987	5,258	10,840	980	8,984	4,894	8,210	1,789		80,512
Seal Island		13,818	8,894	11,560	19,019	23,420	25,344	12,740	10,455	3,874	2,820	465	1,567	492	543	534		135,545
Trinity		35,805	13,433	18,715	18,539	266	1,113	3,039	4,499	1,348	2,366	370	3,448	5,308	2,758	1,256		112,264
Yankee Bank					194	250	3,647	817	119	10	175	323	9	4	219	82		5,849
Unknown	45	66	3,464	5,693	3,426	4,956	4,049	2,753	3,690	193		73				408		28,816
4WX Stock Total	1,291	81,958	57,745	71,661	102,015	78,287	94,127	82,314	57,888	27,703	50,345	49,348	47,606	40,319	71,671	73,758	259	988,295
Misc Nonstock Areas																		
Georges Bank							91	64			266		2,491	79				2,990
Liverpool								13		4,067	4,177							8,257
Shelburne				59				64		526	161		56					865
Halifax										652	1,945		585	455			1,019	4,656
Offshore Banks													11,800	18,770	4,339	8,669		43,577
Western Hole			41	154				213	3,451	2,255	1,495	108	127	691	1,013	1,057		10,605
Sydney Bight		3,511	4,250	1,751	2,100	1,330	3,591	3,606		396		3,951	4,267		52			28,804
Overall Total	1,291	85,468	62,036	73,625	104,116	79,617	97,809	86,273	61,339	35,598	58,389	53,407	66,931	60,314	77,075	83,484	1,278	1,088,050

Table 3b. Summary of the percentage of herring purse seine catches from 1984 to 2000 by year and fishing grounds.

	Year															
S.W. Nova Grounds	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Browns Bank			1%						0%		3%	3%	0%	0%	4%	2%
Chedabucto Bay	38%	5%	7%	1%	4%	4%	9%	12%		4%	2%	4%	3%		2%	1%
Gannet,Dry Ledge		7%	4%	2%	14%	3%	4%	7%	30%	8%	4%	5%	3%	8%	6%	12%
German Bank		18%	22%	22%	18%	10%	12%	27%	5%	11%	17%	3%	24%	23%	27%	30%
Grand Manan	29%	6%	9%	6%	4%	5%	6%	5%	4%	2%	12%	10%	9%	9%	20%	9%
Long Island		1%	5%	10%	10%	27%	19%	11%	5%	8%	13%	15%	7%	6%	16%	22%
Lurcher		1%	0%		3%	0%	0%	0%	3%	4%	1%	1%	0%	1%	0%	0%
N.B. Coastal	30%	0%	1%	1%	1%	4%	2%	1%	2%	2%	0%	3%	0%	2%	1%	2%
S.W. Grounds		1%	2%	0%	0%	0%	0%	1%	0%	8%	6%	12%	5%	1%	1%	5%
Scots Bay			0%	5%	4%	8%	9%	9%	13%	15%	19%	2%	13%	8%	11%	2%
Seal Island		16%	14%	16%	18%	29%	26%	15%	17%	11%	5%	1%	2%	1%	1%	1%
Trinity		42%	22%	25%	18%	0%	1%	4%	7%	4%	4%	1%	5%	9%	4%	2%
Yankee Bank					0%	0%	4%	1%	0%	0%	0%	1%	0%	0%	0%	0%
Unknown	4%	0%	6%	8%	3%	6%	4%	3%	6%	1%		0%				0%
4WX Stock Total	100%	96%	93%	97%	98%	98%	96%	95%	94%	78%	86%	92%	71%	67%	93%	88%
Misc Nonstock Areas																
Georges Bank							0%	0%			0%		4%	0%		
Liverpool								0%		11%	7%					
Shelburne				0%				0%		1%	0%		0%			
Halifax										2%	3%		1%	1%		
Offshore Banks													18%	31%	6%	10%
Western Hole			0%	0%				0%	6%	6%	3%	0%	0%	1%	1%	1%
Sydney Bight		4%	7%	2%	2%	2%	4%	4%		1%		7%	6%		0%	

Table 4. Acoustic and mapping biomass estimates for spawning components surveyed in the 4WX herring stock complex, 1997 to 1999 (from Melvin et al. 2000).

Location	1997 Observed	1998 Observed	1999 Observed
Scots Bay	160,100	72,500	41,000
Trinity Ledge	23,000	6,800	3,900
German Bank	370,400	440,700	460,800
Spectacle Buoy	15,000	1,300	no survey
Total	**568,500**	**521,300**	**505,700**

Table 5. Summary of biological samples (by fishery and month) taken in the 1999 4VWX herring fisheries.

		Month												
Gear	Data	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
4Vn Purse Seine	Sum of NO_LF							1						1
	Sum of NO_MEAS													
	Sum of Aged							10						10
4W Purse Seine	Sum of NO_LF			1		25	62				1	16		105
	Sum of NO_MEAS					2300	7924				179	1826		12229
	Sum of Aged			28		0	351				35	198		612
5Y Purse Seine	Sum of NO_LF					20	56				1			77
	Sum of NO_MEAS					2311	7373							9684
	Sum of Aged					63	78				24			165
Gillnet	Sum of NO_LF				18	5	2			8	8			41
	Sum of NO_MEAS				2471	565	339			1102	899			5376
	Sum of Aged				170	0	29			261	75			535
N.B. Purse Seine	Sum of NO_LF							2	1		26	1		30
	Sum of NO_MEAS							166	100		2845	131		3242
	Sum of Aged							0	0		153	28		181
N.B. Shut-off	Sum of NO_LF							3	3	4				10
	Sum of NO_MEAS							317	321	448				1086
	Sum of Aged							0	0	0				0
N.B. Weirs	Sum of NO_LF					3	28	135	175	63	3			407
	Sum of NO_MEAS					343	2924	14970	20338	7181	283			46039
	Sum of Aged					0	74	169	226	155	45			669
N.S. Purse Seine	Sum of NO_LF	4			5	8	127	240	123	117	21	1		646
	Sum of NO_MEAS	623			714	1186	15223	29895	15199	13972	3498	100		80410
	Sum of Aged	106			45	23	118	350	631	468	69	0		1810
N.S. Weirs	Sum of NO_LF					51	37	16	4	1				109
	Sum of NO_MEAS					5727	4021	1852	367	106				12073
	Sum of Aged					190	188	177	36	14				605
Otter Trawl	Sum of NO_LF			8	3	5								16
	Sum of NO_MEAS					906								906
	Sum of Aged			199	58	124								381
Research Otter Trawl	Sum of NO_LF		47	35				87		1	10	10		190
	Sum of NO_MEAS										904	797		1701
	Sum of Aged		682	565				613		4	249	226		2339
USA Shut-off	Sum of NO_LF					6		1	1					8
	Sum of NO_MEAS					689		103	257					1049
	Sum of Aged					44		0	28					72
USA Weirs	Sum of NO_LF					1				2		1		4
	Sum of NO_MEAS					113				236				349
	Sum of Aged					0				0		30		30
4T Purse Seine	Sum of NO_LF						1							1
	Sum of NO_MEAS						105							105
	Sum of Aged						0							0
5Y USA P.Seine/ MW Trawl	Sum of NO_LF	2					1			4	6	24	9	46
	Sum of NO_MEAS	232					101			513	602	2503	955	4906
	Sum of Aged	0					0			0	0	22	0	22
5Z USA P.Seine/ MW Trawl	Sum of NO_LF	32												32
	Sum of NO_MEAS	3669												3669
	Sum of Aged	0												0
4Vn Trap	Sum of NO_LF						1							1
	Sum of NO_MEAS						166							166
	Sum of Aged						37							37
Total Number of Length Frequencies		38	47	44	26	124	315	485	307	200	76	53	9	1724
Total Number of Herring Measured		4524			3185	14142	38176	47303	36582	23558	9210	5357	955	182992
Total Number of Herring Aged		106	682	792	273	444	875	1319	921	902	650	504	0	7468

Table 6. Number of herring samples collected by DFO personnel from commercial fisheries (Commercial), independent observers on foreign vessels (OSS), DFO research surveys (Research), observer program (Observer) and by members of the fishing industry (Industry).

	Sample Source					
Year	Commercial	Industry	Observer	OSS	Research	Total
1990	422			185		607
1991	448			167	1	616
1992	330			205	1	536
1993	183			421		604
1994	223			228	14	465
1995	138			244	108	490
1996	127	868	49		69	1113
1997	78	1443			114	1635
1998	225	1376			98	1699
1999	49	1388	89		198	1724
2000	3	7	6			16
Total	2226	5082	144	1450	603	9505

Table 7. Herring catch at age for the 1999 purse seine, weir and gillnet fisheries conducted on the southwest Nova Scotia spawning component (4WX stock).

SW Nova Scotia Stock Component - Catch at age (number and weight) 1999 [revised 4/26/00]

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Number	2,894	112,893	223,283	147,840	131,463	57,291	10,044	613	212	70	13	686,415
% number	0	16	33	22	19	8	1	0	0	0	0	100
Catch wt. (t)	53	4,748	18,856	17,779	22,584	12,595	2,645	186	73	28	5	77,552
% catch wt.	0	6	22	23	29	16	3	0	0	0	0	100
Avg. wt.	20	42	75	120	172	220	263	304	344	378	398	

Herring catch at age for 1999 southwest Nova Scotia stock component by gear type [revised 4/26/00]

Catch Numbers (000's)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
4W Purse Seine	0	0	908	4,140	2,136	1,488	432	36	20	10	4	9,175
4X N.S. Purse Seine	2,323	80,742	174,887	137,084	124,501	51,505	8,297	452	132	38	8	579,945
4X N.S. Weir	370	32,151	47,468	5,928	2,548	927	153	18	2	8	0	89,571
4X Gillnet	0	0	21	708	2,278	3,372	1,162	106	58	19	0	7,724
Total Numbers by Age	2,694	112,893	223,283	147,840	131,463	57,291	10,044	613	212	70	13	686,415

Percent Numbers	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
4W Purse Seine	0	0	10	45	23	16	5	0	0	0	0	100
4X N.S. Purse Seine	0	14	30	24	21	9	1	0	0	0	0	100
4X N.S. Weir	0	36	53	7	3	1	0	0	0	0	0	100
4X Gillnet	0	0	0	9	29	44	15	1	1	0	0	100
Percent Numbers by Age	0	16	33	22	19	8	1	0	0	0	0	100

Catch Weight (t)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
4W Purse Seine	0	0	54	375	360	266	122	22	6	5	3	1,233
4X N.S. Purse Seine	42	3,712	13,701	16,573	21,459	11,317	2,192	136	46	14	4	69,196
4X N.S. Weir	11	1,036	3,069	648	421	207	40	6	1	2	0	5,461
4X Gillnet	0	0	1	83	343	702	434	71	19	23	5	1,660
Total Weight (t) by Age	53	4,748	16,845	17,680	22,674	12,523	2,788	236	70	43	12	77,552

Percent Weight	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
4W Purse Seine	0	0	4	30	29	24	10	2	0	0	0	100
4X N.S. Purse Seine	0	5	20	24	31	16	3	0	0	0	0	100
4X N.S. Weir	0	19	57	12	8	4	1	0	0	0	0	100
4X Gillnet	0	0	0	4	21	42	26	4	1	1	0	100
Percent Weight by Age	0	6	22	23	29	16	4	0	0	0	0	100

Table 8a. Catch at age (millions) for the Southwest Nova Scotia / Bay of Fundy herring spawning component, 1965-1999.

	Year											
Year	1	2	3	4	5	6	7	8	9	10	11+	Total
1965	270	1,085	35	234	50	11	2	1	0	0	0	1,687
1966	154	914	449	73	322	46	14	8	2	0	0	1,982
1967	722	614	154	266	110	159	56	4	0	0	0	2,069
1968	165	2,389	225	83	290	73	91	32	15	6	1	3,370
1969	109	290	532	132	162	113	63	23	6	3	1	1,433
1970	700	577	77	286	201	120	112	41	21	7	3	2,145
1971	88	404	184	107	114	76	94	50	37	8	6	1,165
1972	0	649	72	149	77	75	49	49	26	14	12	1,172
1973	1	167	781	131	40	30	22	20	24	12	13	1,242
1974	18	766	94	804	68	19	10	7	13	7	9	1,815
1975	3	318	240	125	515	66	12	4	5	4	6	1,298
1976	0	56	207	154	69	269	21	6	4	2	3	790
1977	1	154	32	218	119	51	177	14	3	1	4	775
1978	35	384	41	13	122	68	31	109	11	2	2	819
1979	0	184	250	55	5	23	18	12	41	5	2	596
1980	2	13	81	474	28	4	5	7	3	11	3	629
1981	0	103	51	103	451	33	2	3	2	1	2	751
1982	4	102	151	23	98	211	15	2	1	1	1	609
1983	5	192	150	244	24	61	90	10	2	1	1	781
1984	0	88	244	224	146	23	22	28	10	2	9	796
1985	9	217	338	303	148	42	14	18	8	1	0	1,098
1986	0	125	276	293	57	32	11	4	3	1	0	802
1987	2	83	126	527	243	46	19	7	3	3	1	1,062
1988	0	148	113	195	434	238	43	21	4	4	3	1,202
1989	0	102	114	62	79	169	77	18	8	4	3	636
1990	0	179	130	172	90	101	202	117	31	11	7	1,039
1991	0	97	179	184	88	41	50	81	46	18	14	798
1992	0	169	133	287	127	75	34	35	59	35	21	974
1993	0	76	44	194	131	68	34	21	22	21	11	622
1994	0	104	142	54	118	73	36	15	9	10	16	576
1995	2	113	220	112	37	36	22	6	4	3	4	560
1996	0	37	38	256	55	17	9	3	2	1	2	420
1997	0	57	87	78	131	19	5	4	1	1	1	384
1998	0	265	62	139	97	97	21	4	2	1	0	689
1999	3	100	219	150	131	70	15	2	0	0	0	691
1999 rev.	3	113	223	148	131	57	10	1	0	0	0	686

Table 8b. Catch at age (%) for the Southwest Nova Scotia / Bay of Fundy herring spawning component, 1965-1999.

	Year										
Year	1	2	3	4	5	6	7	8	9	10	11+
1965	16	64	2	14	3	1					
1966	8	46	23	4	16	2	1				
1967	35	29	7	13	5	8	3				
1968	5	71	7	2	9	2	3	1			
1969	8	20	37	9	11	8	4	2			
1970	33	27	4	13	9	6	5	2	1		
1971	8	35	16	9	10	6	8	4	3	1	
1972		55	6	13	7	6	4	4	2	1	1
1973		13	63	11	3	2	2	2	2	1	1
1974	1	42	5	44	4	1	1		1		
1975		24	18	10	40	5	1				
1976		7	26	19	9	34	3	1			
1977		20	4	28	15	7	23	2			1
1978	4	47	5	2	15	8	4	13	1		
1979		31	42	9	1	4	3	2	7	1	
1980		2	13	75	4	1	1	1		2	
1981		14	7	14	60	4					
1982	1	17	25	4	16	35	2				
1983	1	25	19	31	3	8	12	1			
1984		11	31	28	18	3	3	4	1		1
1985	1	20	31	28	13	4	1	2	1		
1986		16	34	36	7	4	1	1			
1987		8	12	50	23	4	2	1			
1988		12	9	16	36	20	4	2			
1989		16	18	10	12	27	12	3	1	1	
1990		17	13	17	9	10	19	11	3	1	1
1991		12	22	23	11	5	6	10	6	2	2
1992		17	14	29	13	8	4	4	6	4	2
1993		12	7	31	21	11	5	3	4	3	2
1994		18	25	9	20	13	6	3	2	2	3
1995		20	39	20	7	7	4	1	1	1	1
1996		9	9	61	13	4	2	1			
1997		15	23	20	34	5	1	1			
1998		38	9	20	14	14	3	1			
1999		15	32	22	19	10	2				
1999 rev.		16	33	22	19	8	1				

Table 9. Average weights at age (g) for the SW Nova Scotia component of the 4WX herring fishery (weighted by fishery) for 1965-1999.

	Year									
Year	1	2	3	4	5	6	7	8	9	10
1965	10	41	112	172	218	254	286	323	354	389
1966	10	41	112	172	218	254	286	323	354	389
1967	10	41	112	172	218	254	286	323	354	389
1968	10	33	112	148	185	244	276	399	338	410
1969	10	37	105	162	207	242	282	306	334	390
1970	10	32	119	169	211	257	292	332	369	389
1971	10	66	143	199	230	254	293	329	362	388
1972	10	44	138	192	223	262	292	322	345	380
1973	10	29	106	143	225	252	279	331	360	389
1974	10	48	110	175	206	240	277	322	342	352
1975	10	21	94	179	216	240	268	333	358	379
1976	10	33	114	159	233	249	277	317	382	404
1977	10	65	113	174	214	274	293	325	328	416
1978	10	28	112	181	229	259	302	330	351	397
1979	10	41	112	172	218	254	286	323	354	389
1980	10	41	112	172	218	254	286	323	354	389
1981	10	41	112	172	218	254	286	323	354	389
1982	10	41	112	172	218	254	286	323	354	389
1983	10	41	112	172	218	254	286	323	354	389
1984	10	38	132	191	229	259	280	296	309	364
1985	10	53	118	204	249	278	315	334	344	440
1986	10	55	124	182	239	271	306	329	360	400
1987	12	50	98	153	199	245	274	290	318	350
1988	13	21	88	154	196	242	281	304	327	341
1989	7	33	79	162	207	236	274	303	324	353
1990	10	31	92	161	200	234	255	287	319	336
1991	10	48	100	147	186	217	251	270	303	322
1992	9	25	100	148	181	216	252	275	295	313
1993	18	29	108	153	188	215	251	279	302	324
1994	12	37	79	131	175	203	223	253	289	304
1995	15	42	76	136	187	223	247	293	300	326
1996	10	33	98	137	188	228	266	308	332	355
1997	19	34	80	161	190	238	284	314	358	376
1998	10	38	76	131	177	210	251	296	308	337
1999	19	39	73	114	164	209	256	285	316	358
1999 rev.	20	42	75	120	172	220	263	304	344	378

Table 10. Population numbers at age (millions), 1+ biomass (t) and mature biomass (t) at the beginning of the year, 1965 to 1999 estimated from VPA.

	Age												
Year	1	2	3	4	5	6	7	8	9	10	Popn 1+ Numbers	Popn 1+ Biomass ('000s)	Mature 3+ Biomass ('000s)
1965	3,486	3,848	1,006	1,307	339	82	34	5	1	1	10,130	443	183
1966	2,746	2,618	2,177	792	859	233	66	27	4	1	9,522	573	287
1967	6,074	2,109	1,325	1,378	583	415	149	41	15	2	12,091	626	353
1968	1,286	4,322	1,176	946	889	378	197	70	30	12	9,308	623	381
1969	1,756	906	1,413	760	700	467	244	81	29	11	6,364	538	362
1970	2,302	1,338	481	680	503	427	281	143	48	18	8,221	487	366
1971	7,410	1,257	580	325	301	232	241	130	80	18	10,575	411	274
1972	1,140	5,987	666	310	171	145	122	114	62	33	8,750	420	196
1973	2,347	933	4,317	481	121	71	51	56	50	27	8,454	489	132
1974	1,627	1,921	613	2,831	278	63	31	22	28	19	7,432	567	281
1975	237	1,316	887	418	1,597	185	35	16	12	11	4,693	508	367
1976	724	191	792	511	230	848	78	17	9	6	3,401	381	300
1977	4,159	582	107	463	280	127	451	43	9	4	6,235	335	250
1978	1,349	3,404	347	59	184	123	58	211	22	5	5,761	259	158
1979	480	1,073	2,441	247	37	42	40	20	75	8	4,463	258	80
1980	1,596	392	713	1,773	153	25	14	16	6	25	4,713	366	176
1981	1,673	1,305	310	511	1,026	100	17	7	7	2	4,958	359	248
1982	2,297	1,370	975	208	326	436	52	11	4	4	5,684	320	184
1983	4,097	1,878	1,029	663	150	179	189	30	7	2	8,203	360	172
1984	5,029	3,360	1,364	707	324	101	92	58	15	5	11,045	427	181
1985	1,836	4,117	2,663	868	378	135	62	56	22	4	10,170	588	225
1986	1,062	1,495	3,175	1,878	484	177	72	38	29	11	8,400	788	323
1987	1,401	870	1,111	2,351	1,272	328	117	50	27	21	7,548	822	522
1988	1,404	1,145	637	796	1,450	823	227	78	34	19	6,615	700	555
1989	1,751	1,150	804	420	476	798	462	148	45	24	6,077	564	458
1990	1,197	1,433	849	555	288	318	501	309	105	29	5,586	510	400
1991	589	980	1,013	578	301	155	170	230	149	57	4,222	397	277
1992	883	482	715	668	309	167	90	94	116	61	3,604	330	223
1993	2,097	723	244	466	290	140	89	43	45	42	4,159	238	153
1994	2,358	1,716	523	180	208	121	54	27	16	17	5,200	204	92
1995	3,189	1,930	1,312	301	83	65	34	12	8	5	6,920	221	59
1996	2,705	2,593	1,478	876	148	35	21	9	4	3	7,870	307	91
1997	5,274	2,215	2,089	1,178	487	70	14	9	4	2	11,341	457	165
1998	3,616	4,318	1,762	1,631	882	281	41	7	4	3	12,556	632	300
1999	126	2,961	3,296	1,387	1,210	643	143	15	2	2	9,785	776	428
2000	1,000	100	2,334	2,501	1,000	873	484	103	11	1	8,388	921	609

Table 11. Fishing mortality (F) at age, 1965 to 1999 from VPA.

	Age										
Year	1	2	3	4	5	6	7	8	9	10	Avg 5-7
1965	0.09	0.37	0.04	0.22	0.18	0.14	0.06	0.13	0.07	0.06	0.12
1966	0.06	0.48	0.26	0.11	0.53	0.24	0.27	0.38	0.68	0.44	0.35
1967	0.14	0.38	0.14	0.24	0.23	0.54	0.55	0.13	0.03	0.24	0.44
1968	0.15	0.92	0.24	0.10	0.44	0.24	0.70	0.68	0.83	0.74	0.46
1969	0.07	0.43	0.53	0.21	0.29	0.31	0.33	0.37	0.27	0.32	0.31
1970	0.41	0.64	0.19	0.62	0.57	0.37	0.57	0.38	0.71	0.55	0.50
1971	0.01	0.43	0.43	0.44	0.53	0.44	0.55	0.54	0.69	0.59	0.51
1972	0.00	0.13	0.13	0.74	0.68	0.84	0.58	0.63	0.62	0.61	0.70
1973	0.00	0.22	0.22	0.35	0.45	0.63	0.63	0.50	0.74	0.63	0.57
1974	0.01	0.57	0.18	0.37	0.32	0.40	0.45	0.39	0.70	0.51	0.39
1975	0.02	0.31	0.35	0.40	0.44	0.58	0.49	0.36	0.54	0.47	0.50
1976	0.00	0.38	0.34	0.40	0.40	0.43	0.37	0.43	0.64	0.48	0.40
1977	0.00	0.34	0.39	0.72	0.62	0.58	0.56	0.45	0.47	0.49	0.59
1978	0.03	0.13	0.14	0.28	1.27	0.93	0.87	0.83	0.78	0.83	1.02
1979	0.00	0.21	0.12	0.28	0.18	0.90	0.70	1.04	0.91	0.88	0.59
1980	0.00	0.04	0.13	0.35	0.22	0.21	0.45	0.58	0.84	0.63	0.30
1981	0.00	0.09	0.20	0.25	0.65	0.45	0.17	0.53	0.33	0.35	0.43
1982	0.00	0.09	0.19	0.13	0.40	0.75	0.37	0.22	0.55	0.38	0.51
1983	0.00	0.12	0.18	0.52	0.20	0.47	0.87	0.48	0.29	0.55	0.51
1984	0.00	0.03	0.22	0.43	0.68	0.28	0.30	0.75	1.15	0.73	0.42
1985	0.01	0.06	0.15	0.46	0.56	0.42	0.29	0.44	0.49	0.41	0.42
1986	0.00	0.10	0.10	0.19	0.15	0.22	0.18	0.13	0.12	0.14	0.18
1987	0.00	0.11	0.13	0.28	0.24	0.17	0.20	0.18	0.15	0.18	0.20
1988	0.00	0.15	0.22	0.31	0.40	0.38	0.23	0.35	0.15	0.24	0.34
1989	0.00	0.10	0.17	0.18	0.20	0.26	0.20	0.15	0.23	0.19	0.22
1990	0.00	0.15	0.18	0.41	0.42	0.43	0.58	0.53	0.40	0.50	0.48
1991	0.00	0.12	0.22	0.43	0.39	0.35	0.39	0.49	0.41	0.43	0.38
1992	0.00	0.48	0.23	0.63	0.59	0.68	0.54	0.53	0.81	0.63	0.61
1993	0.00	0.12	0.22	0.61	0.68	0.75	0.76	0.79	0.75	0.77	0.73
1994	0.00	0.07	0.35	0.46	0.96	1.05	1.29	0.94	0.91	1.04	1.10
1995	0.00	0.07	0.20	0.53	0.66	0.93	1.19	0.86	0.78	0.94	0.93
1996	0.00	0.02	0.03	0.39	0.53	0.74	0.64	0.54	0.62	0.60	0.64
1997	0.00	0.03	0.05	0.08	0.35	0.35	0.52	0.58	0.27	0.46	0.41
1998	0.00	0.07	0.04	0.10	0.13	0.48	0.81	0.99	0.60	0.80	0.47
1999	0.03	0.04	0.08	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
										Avg 5-7 Overall	0.48

Table 12. 1999 4W offshore herring purse seine and by-catch fisheries catch at age.

1999 Offshore 4W Purse Seine - May to July (revised 4/28/00)
Catch at age (number and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Number	0	0	176	1,354	12,479	36,467	7,231	1,012	180	33	11	58,943
% number	0%	0%	0%	2%	21%	62%	12%	2%	0%	0%	0%	100%
Catch wt. (t)	0	0	15	183	2,183	7,998	1,875	308	64	13	5	12,646
% catch wt.	0%	0%	0%	1%	17%	63%	15%	2%	1%	0%	0%	100%
Avg. wt.			86	135	175	219	259	305	356	406	453	

Offshore 4W and Cuban silver hake fishery (herring by-catch) [revised 4/28/00]
Catch at age (number and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Number	0	0	0	5	18	493	289	45	4	1	2	858
% number	0%	0%	0%	1%	5%	123%	72%	11%	1%	0%	1%	214%
Catch wt. (t)	0	0	0	1	3	105	67	12	1	0	1	190
% catch wt.	0%	0%	0%	1%	3%	106%	67%	12%	1%	0%	1%	190%
Avg. wt.			90	124	168	213	233	259	297	342	382	

Table 13. Herring abundance indices: larval abundance index (average number of larvae per m² from 79 index stations) and herring by-catch (stratified numbers per tow) from the July groundfish survey.

Larval Herring Bongo Survey No.per m2 to bottom					Summer groundfish by-catch (mean nos per tow for herring)									
					4WX area combined strata 453/495				4W Only strata 453/466		4X Only strata 470/495		Offshore Banks strata 455/478	
Year	Cruise	Mean	SE	N	Cruise	Mean#	SE	N	Mean#	SE	Mean#	SE	Mean#	SE
70					A175/176	4.1	1.5	95	4.9	2.4	1.6	0.6		
71					A188/189	4.0	1.9	86	2.6	1.2	3.6	2.6		
72	P109	9.4	1.8	79	A200/201	1.4	0.6	105	1.7	1.0	0.5	0.1		
73	P127	6.6	1.3	79	A212/213	0.9	0.3	96	0.4	0.3	1.0	0.4		
74	P147	49.5	10.9	79	A225/226	0.7	0.3	102	0.2	0.0	1.0	0.4		
75	P160	11.7	1.5	58	A236/237	0.9	0.4	104	0.8	0.4	0.7	0.4		
76	P175	13.5	2.9	79	A250/251	0.4	0.2	103	0.1	0.1	0.5	0.3		
77	P190	6.3	1.0	79	A265/266	0.5	0.3	106	0.0	0.0	0.8	0.5		
78	P207	4.5	0.5	77	A279/280	0.3	0.3	103	0.5	0.5	0.1	0.0		
79	P232	7.1	2.1	79	A292/293	0.6	0.5	106	0.0	0.0	1.0	0.7		
80	P246	26.2	6.7	79	A306/307	0.5	0.5	105	0.0	0.0	0.8	0.8		
81	P263	2.7	0.3	78	A321/322	1.5	1.4	104	0.0	0.0	2.3	2.1		
82	P280	10.6	1.2	77	H080/081	1.5	0.9	108	0.5	0.3	1.9	1.4		
83	P298	13.9	1.6	74	N012/013	2.4	0.8	106	2.6	1.2	2.2	1.0	2.1	1.0
84	P315	12.7	1.4	78	N031/032	7.0	3.5	102	3.3	1.2	10.5	6.8	8.5	5.4
85	P329	40.8	4.6	79	N048/049	3.4	1.8	111	6.6	3.8	0.3	0.1	5.0	2.9
86	P344	18.9	2.1	78	N065/066	23.2	14.9	118	30.8	26.7	16.0	14.3	23.4	20.3
87	P361	27.9	3.2	78	N85/86/87	10.4	5.6	135	17.0	11.3	4.0	1.8	12.9	8.6
88	P377	100.7	11.5	76	N105/106	2.1	0.6	127	2.7	1.2	1.5	0.5	2.0	0.9
89	P391	54.5	6.1	79	N123/124	8.4	1.8	124	11.8	3.4	4.5	1.2	9.8	2.7
90	P408	27.2	3.1	79	N139/140	5.6	1.9	156	7.4	3.6	3.4	1.0	6.5	2.9
91	P422	48.2	5.5	78	N154/H231	10.6	5.8	137	13.0	8.8	5.0	1.8	14.3	9.0
92	P437	57.0	6.4	79	N173/174	16.5	4.9	136	16.2	6.6	40.8	15.7	23.6	7.4
93	P451	55.0	6.2	78	N189/190	18.7	4.5	137	6.3	2.5	30.4	8.5	15.0	4.7
94	N211	5.4	0.7	77	N221/222	76.4	30.2	140	108.4	58.9	45.9	18.4	91.1	45.1
95	N232	20.3	4.6	78	N226/227	63.5	24.2	140	100.5	47.9	28.4	12.8	92.7	37.6
96	N252	9.5	1.6	77	N246/247	40.2	14.2	135	53.2	24.5	27.1	14.1	46.5	19.5
97	N765	23.3	2.7	77	N726/734	31.8	15.3	137	34.6	10.1	51.3	39.3	29.3	7.7
98	N865	33.6	3.8	77	N827/832	99.5	20.7	131	147.6	39.9	54.8	14.5	130.3	30.3
99	no survey				N925/929	229.8	83.8	133	264.2	101.0	199.4	130.2	226.2	74.4

Table 14. Recorded landings (t) of herring from major gillnet fisheries on the Coastal Nova Scotia Spawning component.

Landings (t)

	1996	1997	1998	1999
East of Halifax	1,280	1,520	1,100	1,620
Little Hope	-	490	1,170	2,919
Glace Bay	-	170	1,730	1,040
Bras d'Or Lakes	170	160	120	31

Table 15. Summary of herring surveys and tagging trips conducted on the Coastal Nova Scotia Spawning Component.

Location	Survey Date	Type of Survey	No. of Boats	Result
Eastern Shore	1-Oct-99	Tagging	1	1,896 tags applied
	2-Oct-99	Mapping	11	**20,226t**
	4-Oct-99	Acoustic	J.L. Hart	**4,658t**
	10-Oct-99	Mapping	7	**9,500t**
Little Hope	26-Sep-99	Mapping	20	**6,150t**
	3-Oct-99	Acoustic	J.L. Hart	**15,800t**
Glace Bay	21-Sep-99	Mapping	1	**2,000t**
Bras d'Or Lakes	20-Feb-99	Mapping	1	**1,000t** - no sample taken
	8-Apr-99	Mapping	1	**210t**
	9-Apr-99	Mapping	1	**120t**
	14-Apr-99	Portable acoustic and Mapping	1	acoustic (Big Lake only) - **15t** mapping (Great Bras d'Or) - **270t**
	15-Apr-99	Portable acoustic	1	acoustic (Big Lake only) - **20t**

Table 16. Catch at age for herring from Coastal Nova Scotia fisheries in 1999.

1999 4W Eastern Shore herring gillnet (revised 4/28/00)
Catch at age (number and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Number	0	0	0	50	640	3,640	2,050	447	38	13	12	6,899
% number	0	0	0	1	9	53	30	6	1	0	0	100
Catch wt. (t)	0	0	0	8	121	818	520	132	14	5	5	1,620
% catch wt.	0	0	0	1	7	50	32	8	1	0	0	100
Avg. wt.	0	0	0	138	189	224	254	295	357	390	428	

Sept. to Oct., 1999 4X Little Hope Gillnet (revised 4/28/00)
Catch at age (number and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Number	0	0	10	327	2,413	6,944	2,659	147	100	70	11	12,680
% number	0%	0%	0%	3%	19%	55%	21%	1%	1%	1%	0%	100%
Catch wt. (t)	0	0	1	48	442	1,609	707	46	35	27	4	2,919
% catch wt.	0%	0%	0%	2%	15%	55%	24%	2%	1%	1%	0%	100%
Avg. wt.			115	146	183	232	266	312	349	382	410	

1999 Glace Bay herring gillnet (revised 4/28/00)
Catch at age (number and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Number	0	0	0	0	149	1,089	1,915	440	114	56	17	3,780
% number	0%	0%	0%	0%	4%	29%	51%	12%	3%	1%	0%	100%
Catch wt. (t)	0	0	0	0	30	285	536	138	41	22	8	1,040
% catch wt.	0%	0%	0%	0%	3%	25%	51%	13%	4%	2%	1%	100%
Avg. wt.	0	0	0	0	203	243	280	314	364	387	447	

1999 Bras d'Or Lakes herring gillnet (revised 4/28/00)
Catch at age (number and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Number	0	0	0	0	2	9	43	37	8	4	4	108
% number	0%	0%	0%	0%	1%	9%	40%	35%	8%	4%	4%	100%
Catch wt. (t)	0	0	0	0	0	2	12	11	3	1	2	31
% catch wt.	0%	0%	0%	0%	1%	7%	38%	37%	8%	4%	5%	100%
Avg. wt.	0	0	0	0	193	234	274	307	329	358	372	

Table 17. Summary of herring catches in Stratum 442 during the July groundfish survey, 1990 to 1999 in numbers and weight (kg).

Year	Total Number	Average No. Per Set	Total Weight	Average Wt. Per Set
1990	1	0	0	0
1991	11	2	4	1
1992	0	0	0	0
1993	13	3	4	1
1994	1,301	217	432	72
1995	359	60	80	13
1996	0	0	0	0
1997	2	0	1	0
1998	37	7	6	1
1999	1,605	229	431	62
1970-79 Avg.	91	35	39	6
1980-89 Avg.	699	171	195	75
1990-99 Avg.	333	59	96	17

Table 18. Weir catches (t), number of active weirs and the catch per weir, 1978 to 1999.

	Catch (t)			No. Active Weirs			Catch per Weir		
Year	NB	NS	Total Catch	NB	NS	Total No.	NB	NS	Average
1978	33,599	7,858	41,458	208	31	239	162	253	173
1979	32,579	6,339	38,918	210	27	237	155	235	164
1980	11,066	2;383	13,449	120	29	149	92	82	90
1981	14,968	1,824	16,793	147	28	175	102	65	96
1982	22,181	1,130	23,311	159	19	178	140	59	131
1983	12,568	896	13,464	143	23	166	88	39	81
1984	8,353	2,702	11,056	116	13	129	72	208	86
1985	26,718	4,055	30,774	156	14	170	171	290	181
1986	27,516	1,957	29,473	105	18	123	262	109	240
1987	26,621	6,776	33,397	123	21	144	216	323	232
1988	38,235	7,480	45,715	191	21	212	200	356	216
1989	43,520	3,296	46,817	171	20	191	255	165	245
1990	39,808	4,132	43,940	154	22	176	258	188	250
1991	23,717	1,498	25,216	143	20	163	166	75	155
1992	31,961	2,224	34,206	151	12	163	212	185	210
1993	31,328	2,662	33,990	145	10	155	216	266	219
1994	20,618	2,045	22,662	129	11	140	160	186	162
1995	18,228	3,049	21,277	106	10	116	172	305	183
1996	15,781	3,476	19,257	101	12	113	156	290	170
1997	20,396	4,019	24,415	102	15	117	200	268	209
1998	19,113	4,464	23,577	104	14	118	184	319	187
1999	18,234	5,461	23,695	100	14	114	182	390	208
Totals	537,129	79,727	616,856	3084	404	3488	174	212	177

Table 19. New Brunswick weir and shut-off catch at age for herring in 1999.

1999 NB Weir and Shutoff (revised 4/28/00)
Catch at age (number and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Number	107	78,634	102,388	36,782	12,136	3,114	331	3	0	0	8	233,484
% number	0%	34%	44%	16%	5%	1%	0%	0%	0%	0%	0%	100%
Catch wt. (t)	4	3,932	7,568	4,290	2,078	682	85	1	0	0	4	18,644
% catch wt.	0%	21%	41%	23%	11%	4%	0%	0%	0%	0%	0%	100%
Avg. wt.	38	50	74	117	171	219	257	272	0	0	469	

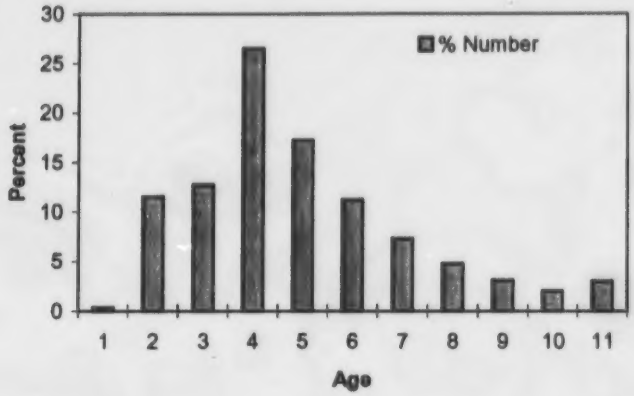


Figure 1. Expected age structure of SW Nova Scotia herring with fishing at F0.1 and constant average recruitment.

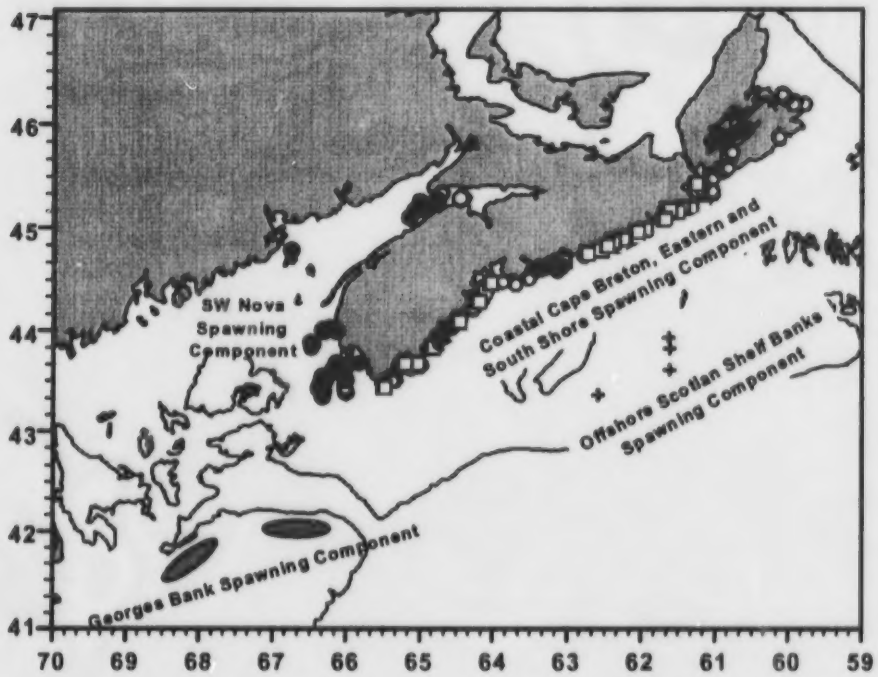


Figure 2. Management units for herring in areas 4VWX and 5 showing locations of known current (solid) and historical (open) spawning locations.

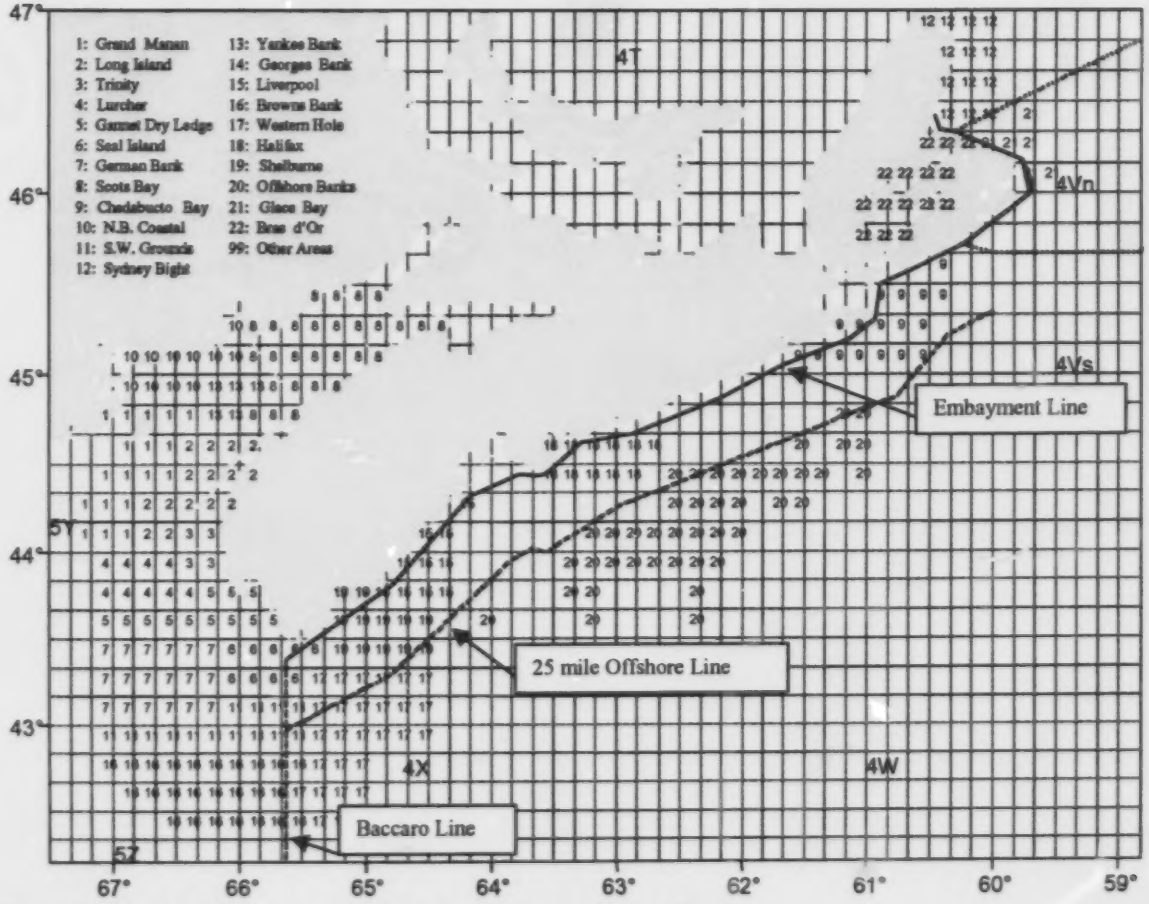


Figure 3. Herring fishing ground areas and management lines.

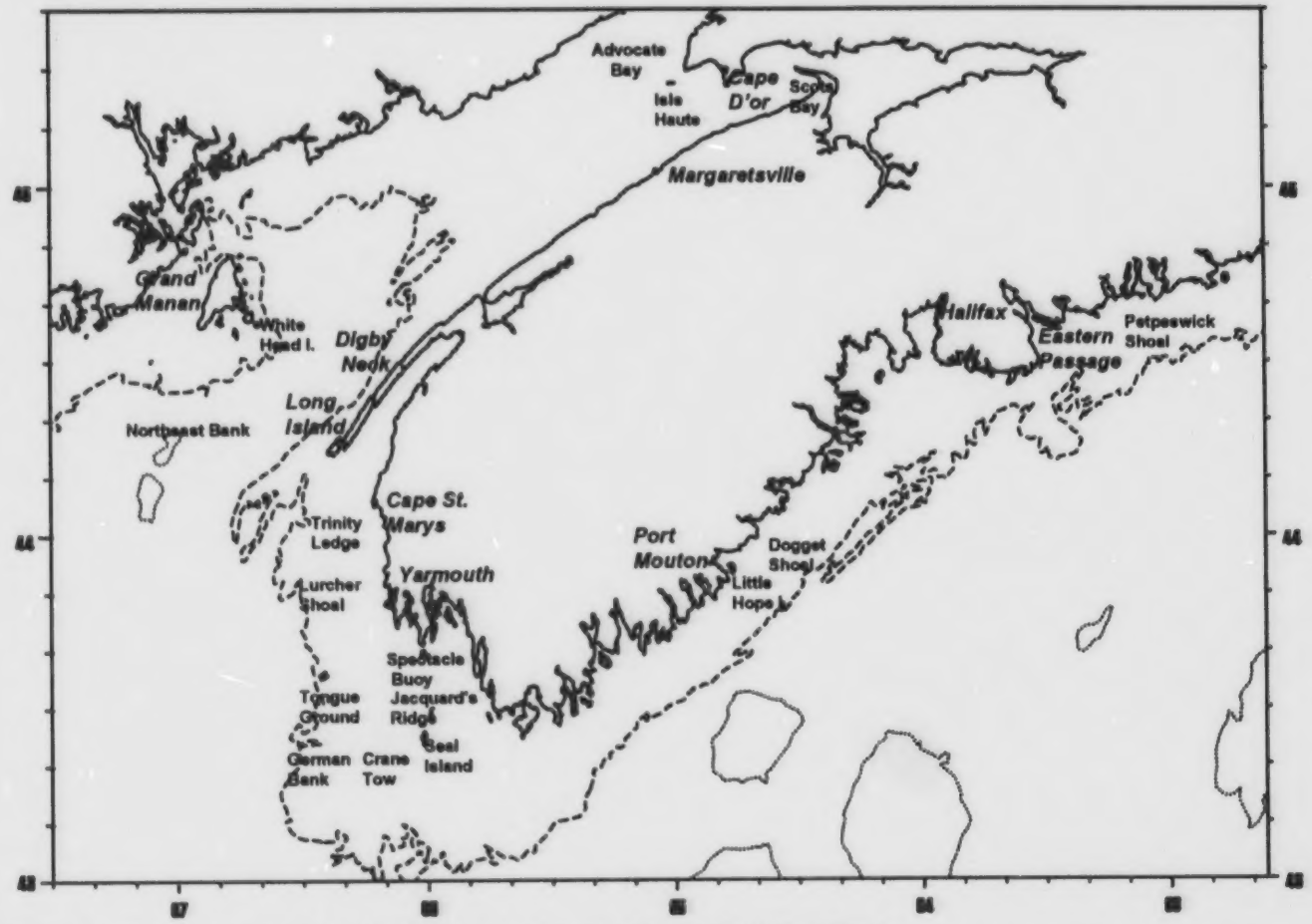


Figure 4. Fishing locations for herring in southwest and coastal Nova Scotia.

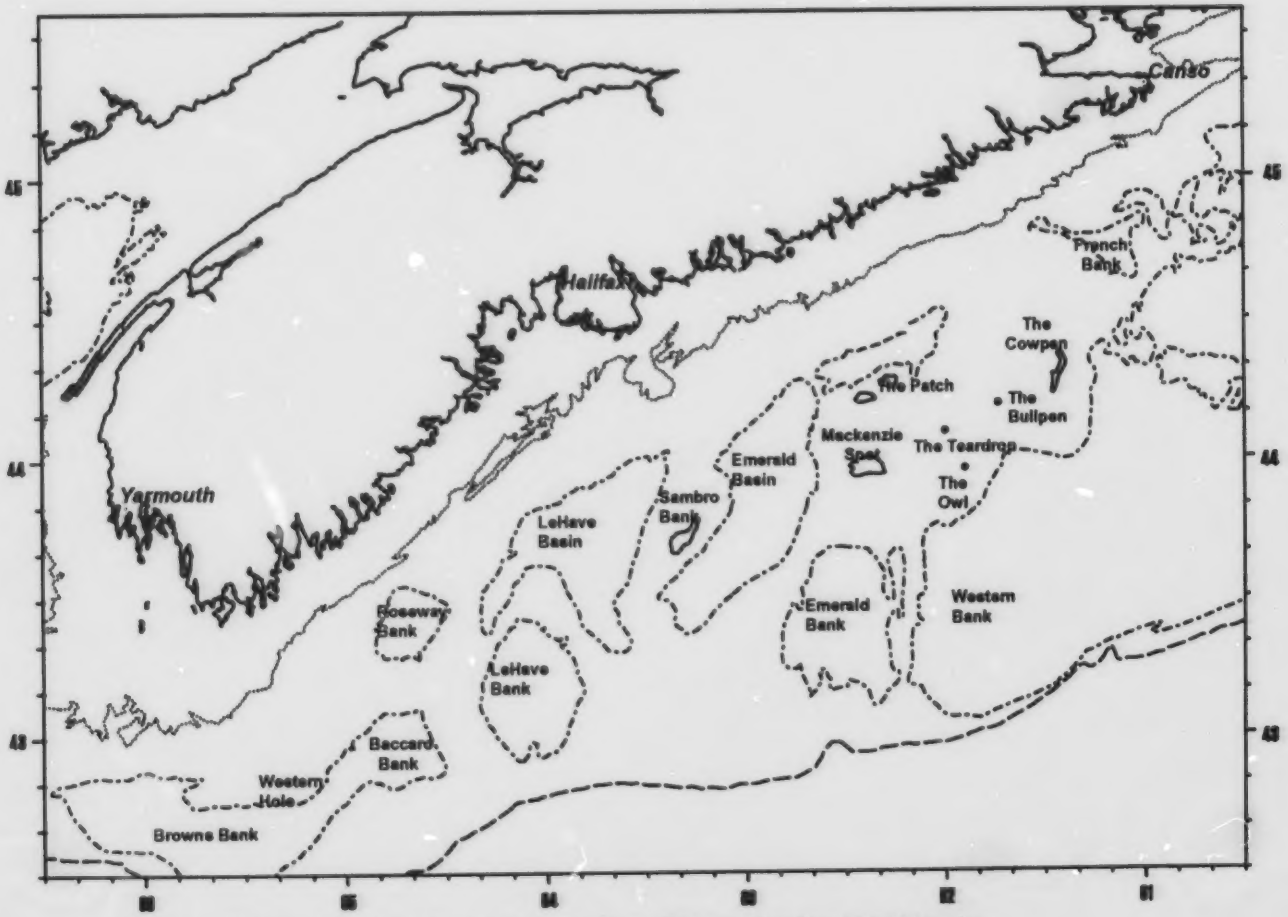


Figure 5. Fishing locations for herring on the offshore Scotian Shelf banks.

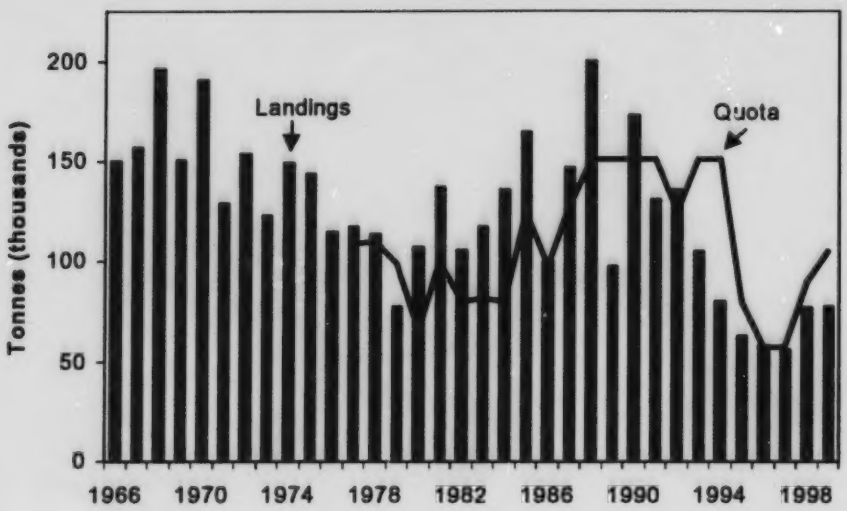


Figure 6. Annual herring landings and TAC (quota) for the southwest Nova Scotia spawning component (4WX stock).

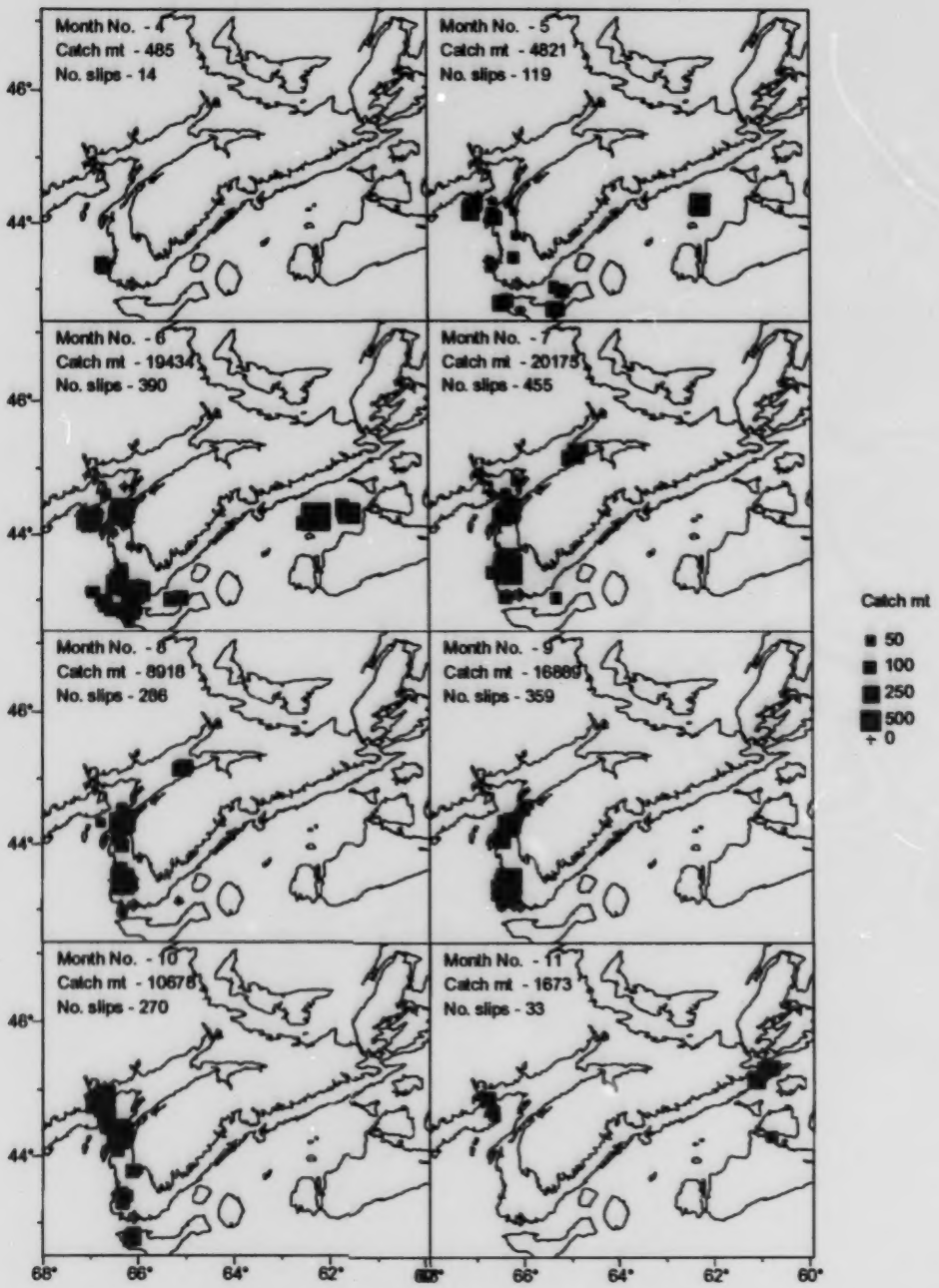


Figure 7. 1999 herring purse seine monthly catches (data aggregated by 1 mile squares).

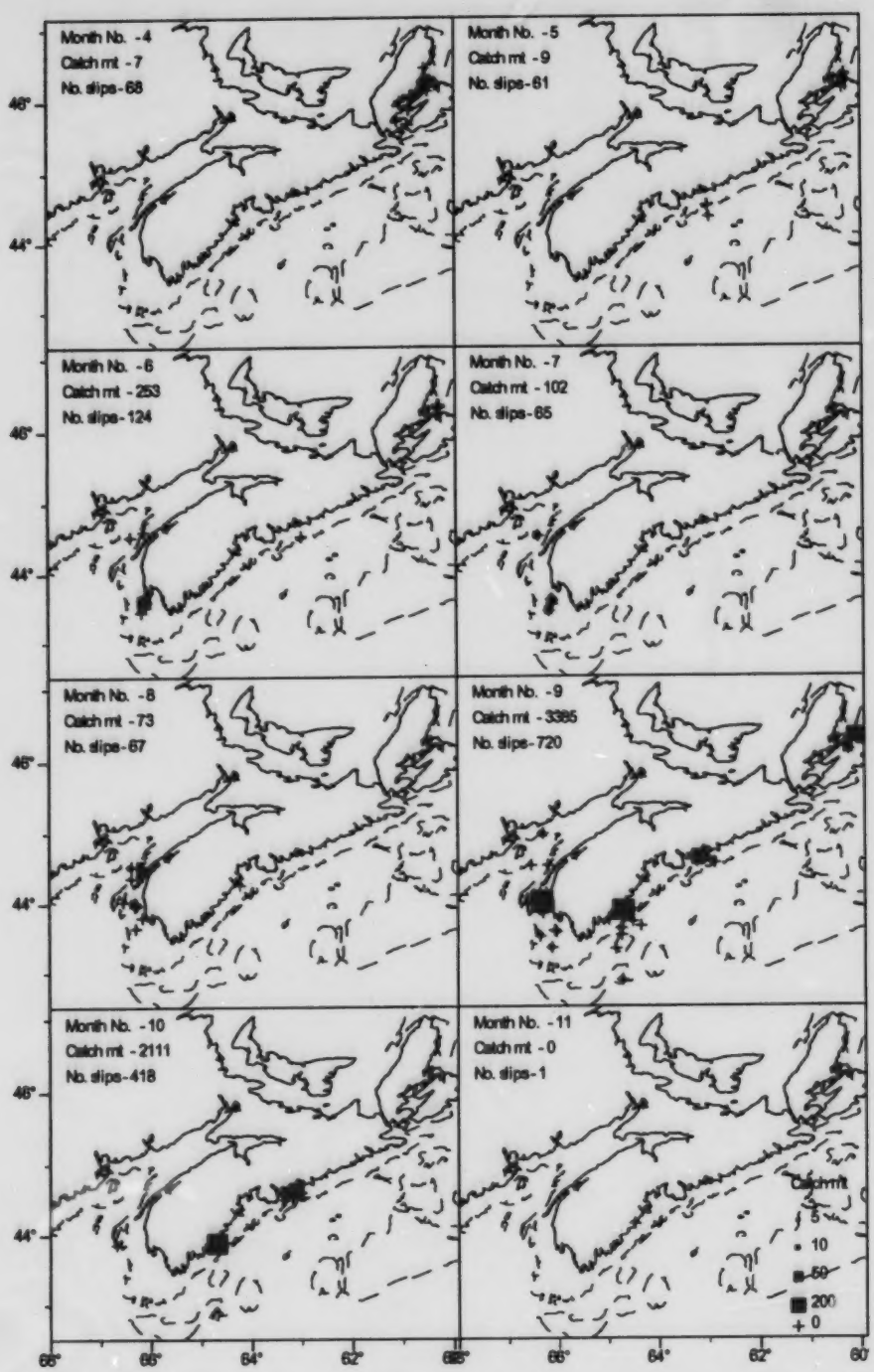


Figure 8. 1999 herring gillnet monthly catches (data aggregated by 1 mile squares).

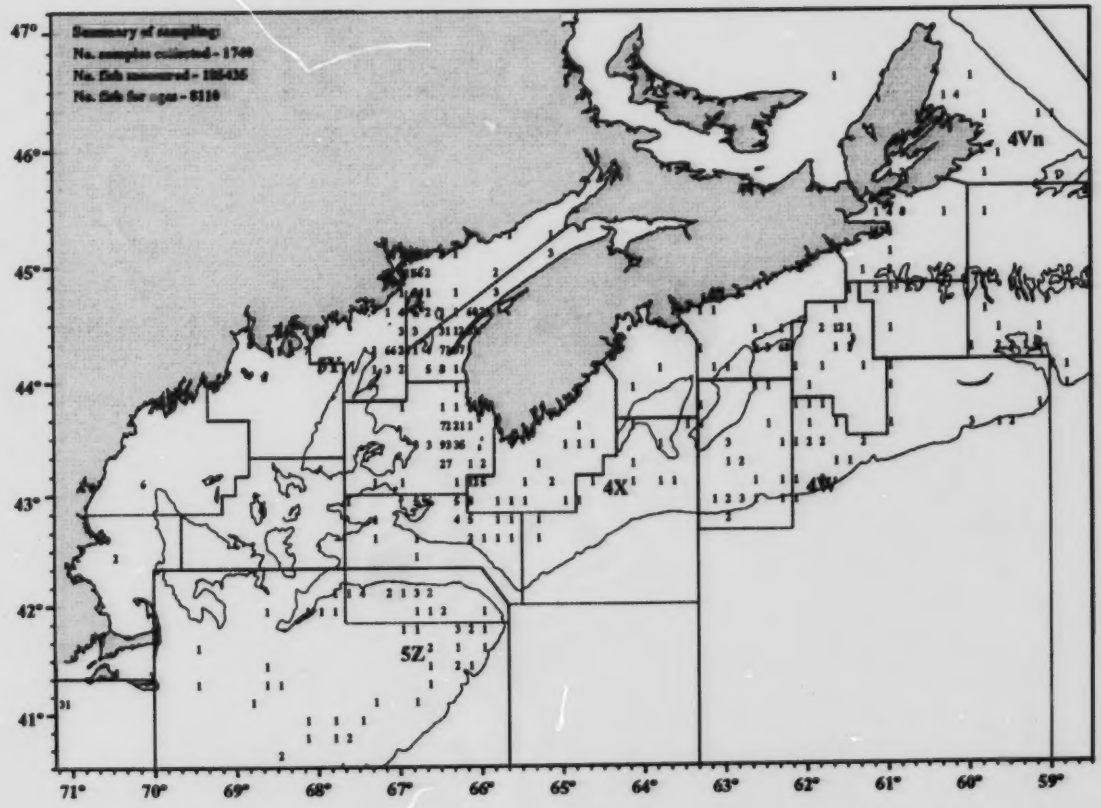


Figure 9. 1999 herring sampling coverage from all sources (number of length frequency samples by 10 mile square)

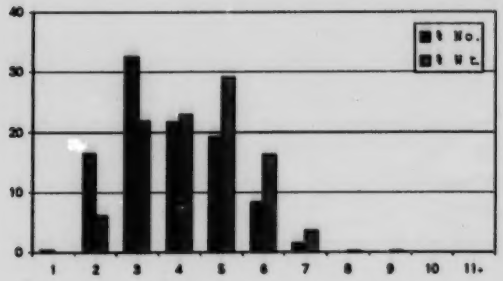


Figure 10a. Catch at age for 1999 for the southwest Nova Scotia spawning component (% numbers and % weight).

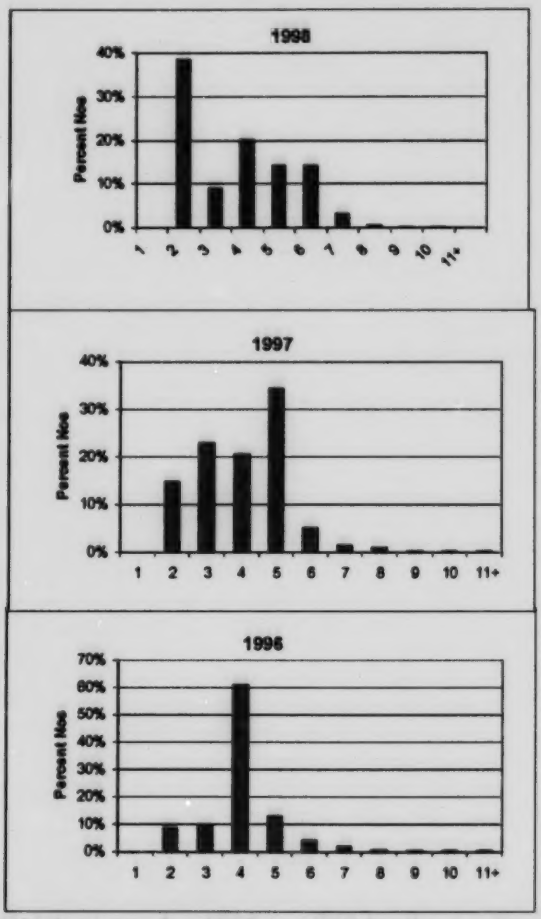


Figure 10b. Catch at age for 1996 to 1998 for the southwest Nova Scotia spawning component (% numbers).

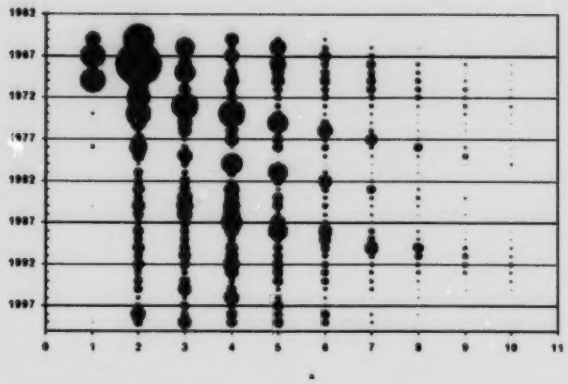


Figure 11. Historic catch at age (numbers) for the SW Nova Scotia spawning component.

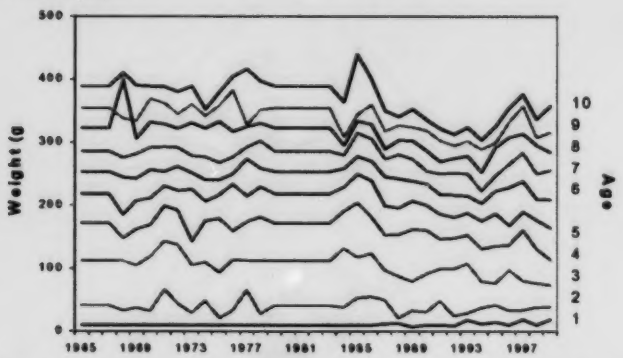


Figure 12. Average weights at age (g) for the SW Nova Scotia component of the 4WX herring fishery (weighted by fishery) for 1965-1999.

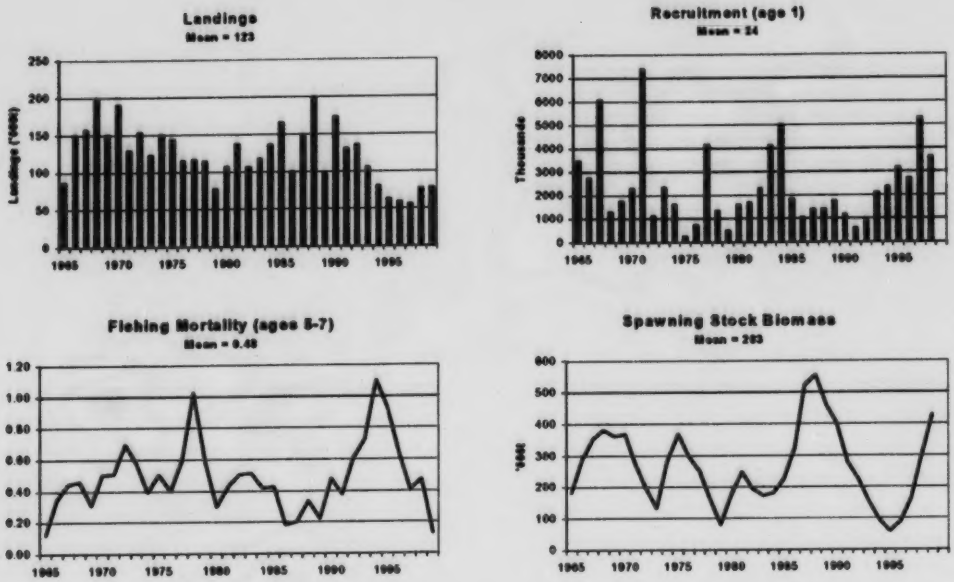


Figure 13. Results of a sequential population analysis with spawning stock biomass in 1999 set to that observed in 1999 acoustic surveys to illustrate the historic development of the stock.

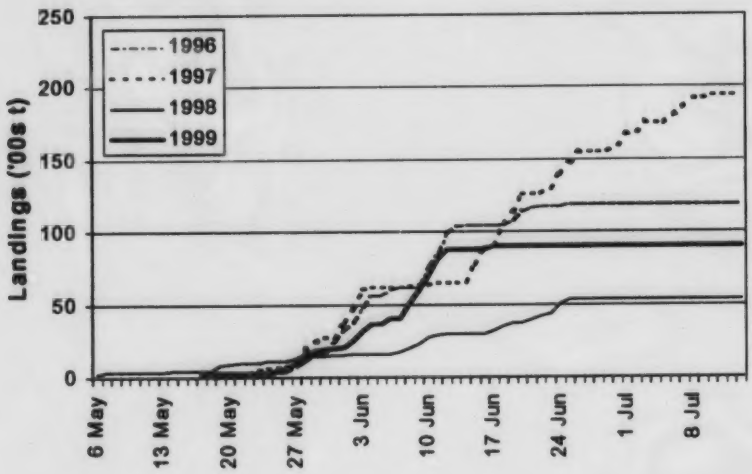


Figure 14. Cumulative catch of the offshore Scotian Shelf herring fishery (1996-1999).

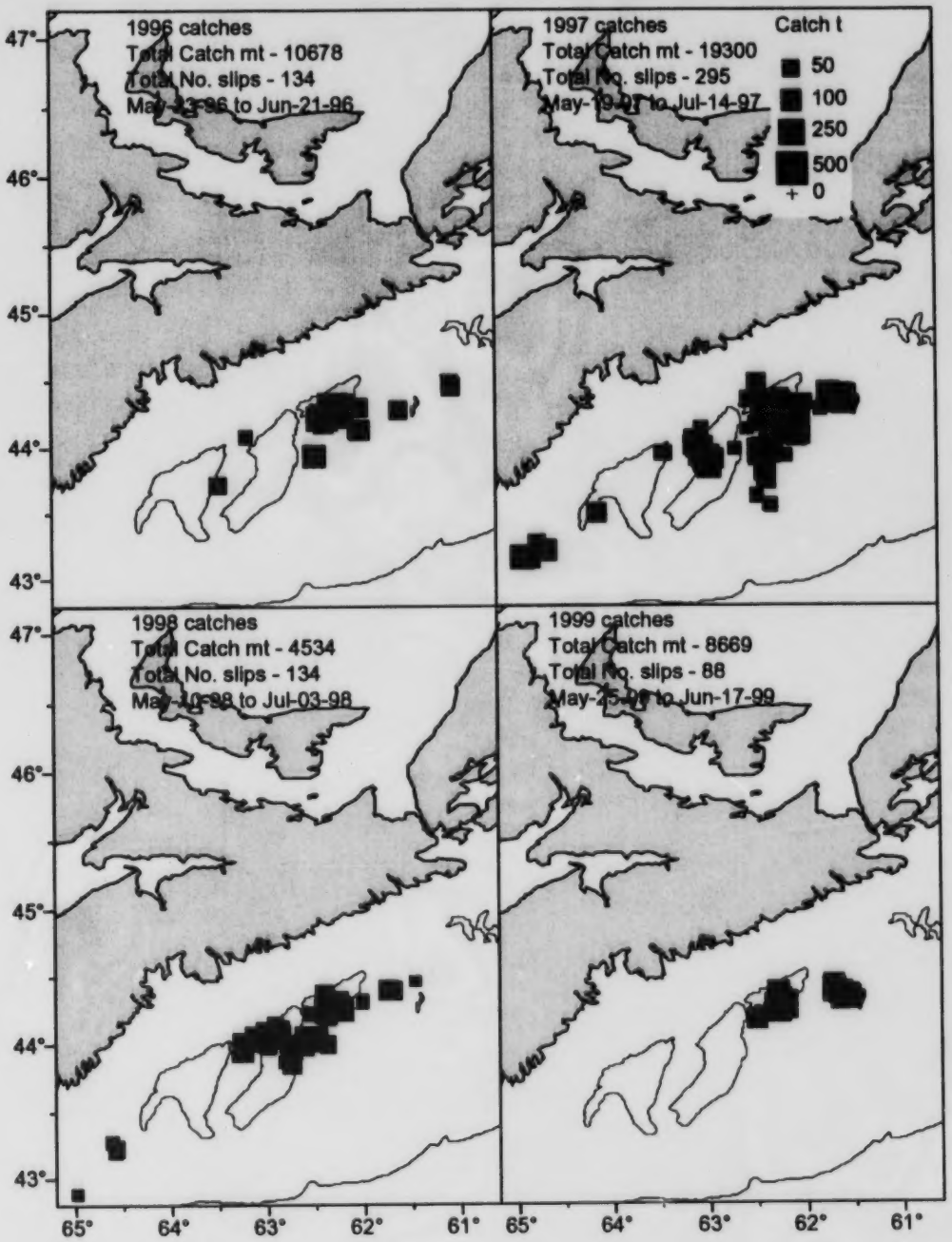


Figure 15. Herring purse seine catches (t) on offshore Scotian Shelf banks, 1996 to 1999.

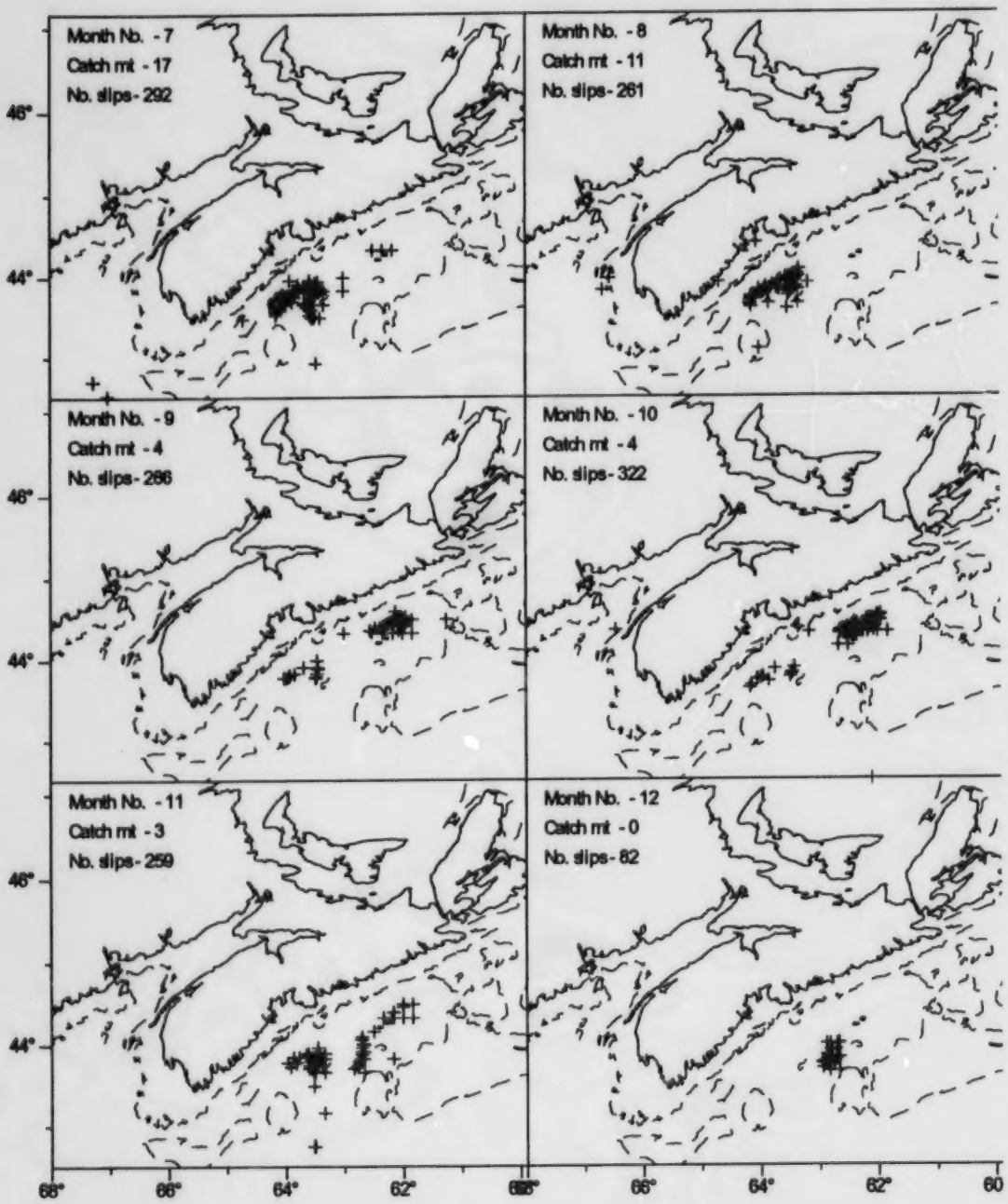


Figure 16. Distribution of domestic bottom trawl herring by-catch by month for 1999.

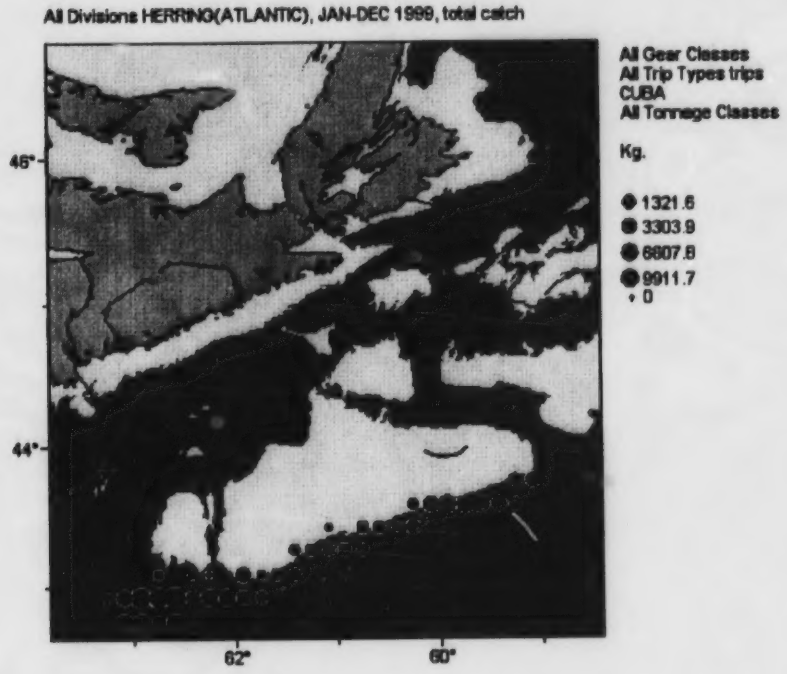


Figure 17. Distribution of herring by-catch (kg) from the Cuban silver hake fishery by 10 minute square (International Observer Database).

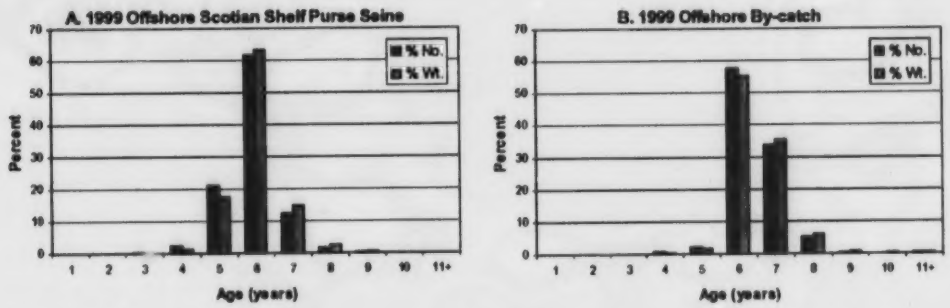


Figure 18. Catch at age for herring for the offshore Scotian Shelf Banks spawning component from (A) the 1999 purse seine fisheries and (B) from by-catch in the Cuban silver hake and domestic bottom trawl fisheries.

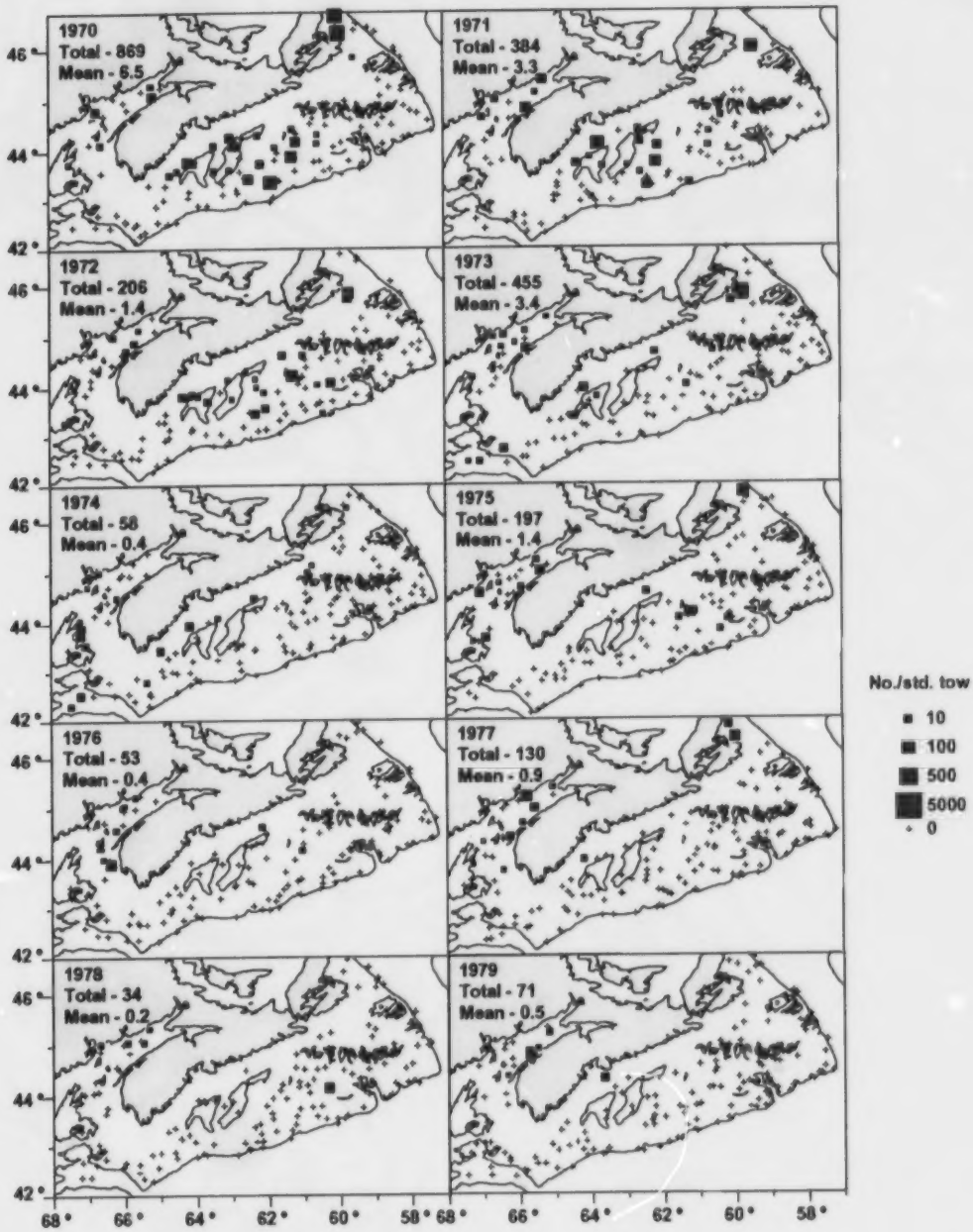


Figure 19. 1970-98 herring catches (numbers per standard tow) in summer ground trawl survey.

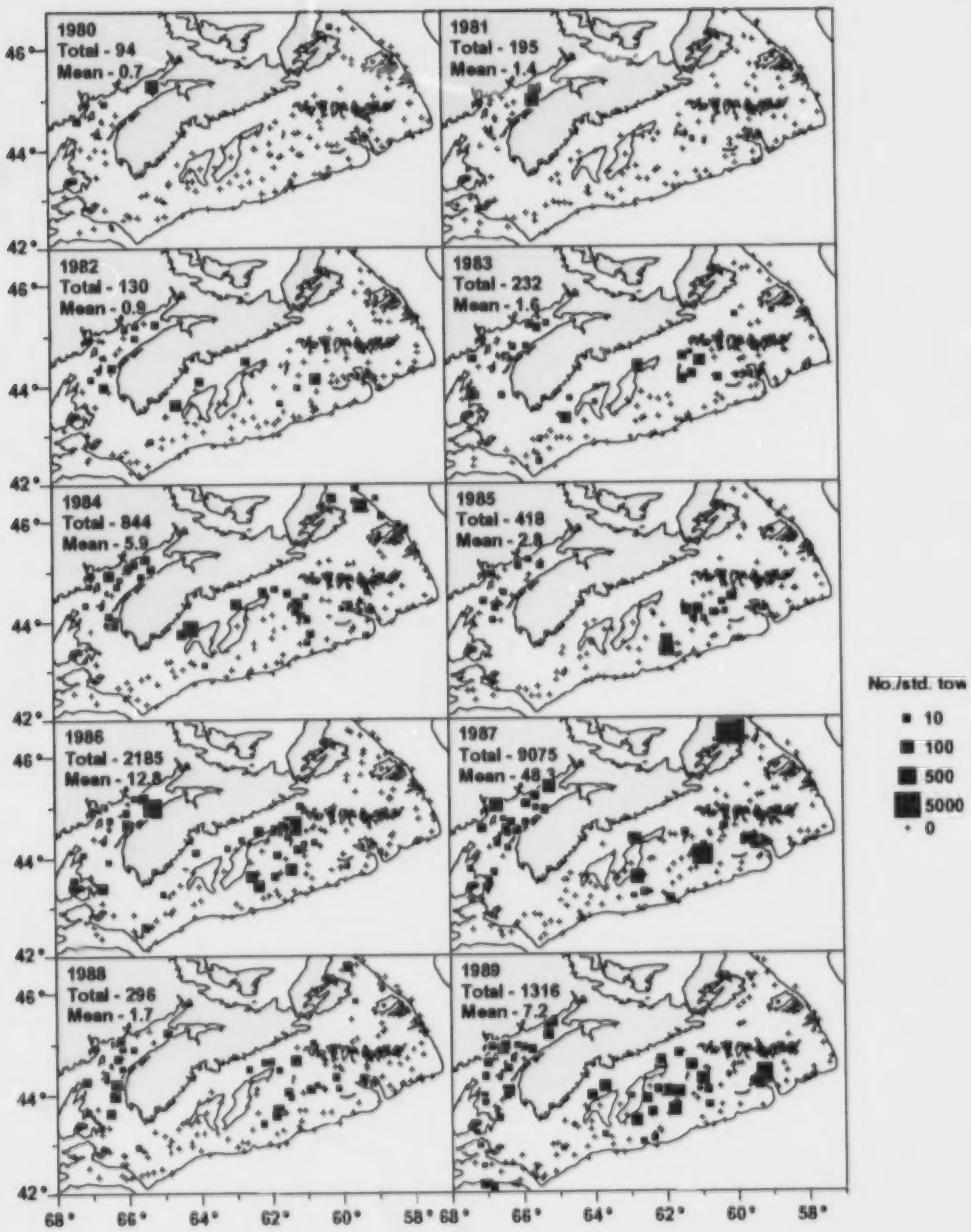


Figure 19. continued.

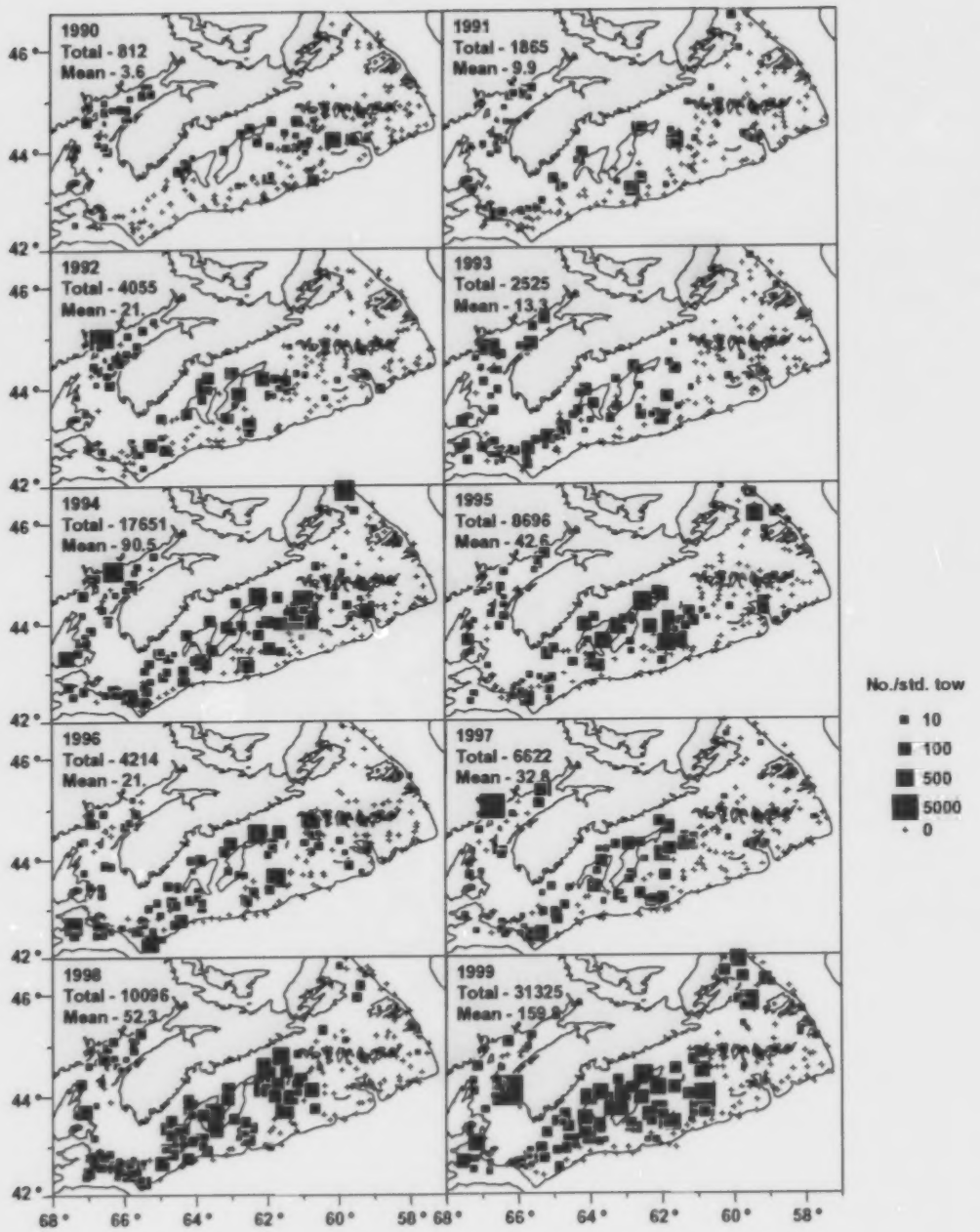


Figure 19. continued.

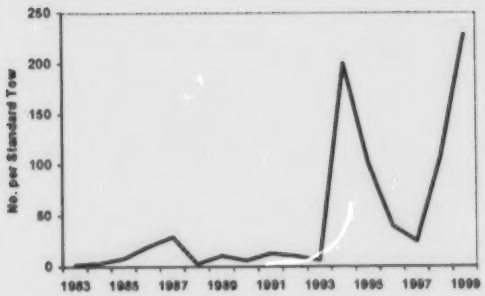


Figure 20. Number of herring caught per standard tow in the July bottom trawl survey of the offshore Scotian Shelf Banks, 1983 to 1999 (strata 55-78).

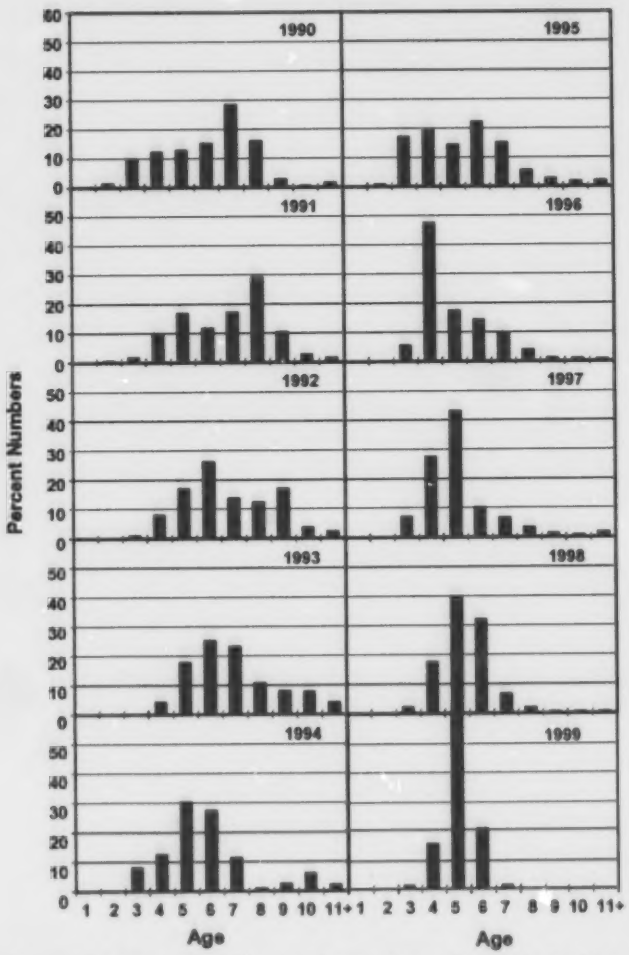


Figure 21. Herring catch at age from the July bottom-trawl survey on the Scotian Shelf (strata 55-78) for years 1990 -1999.

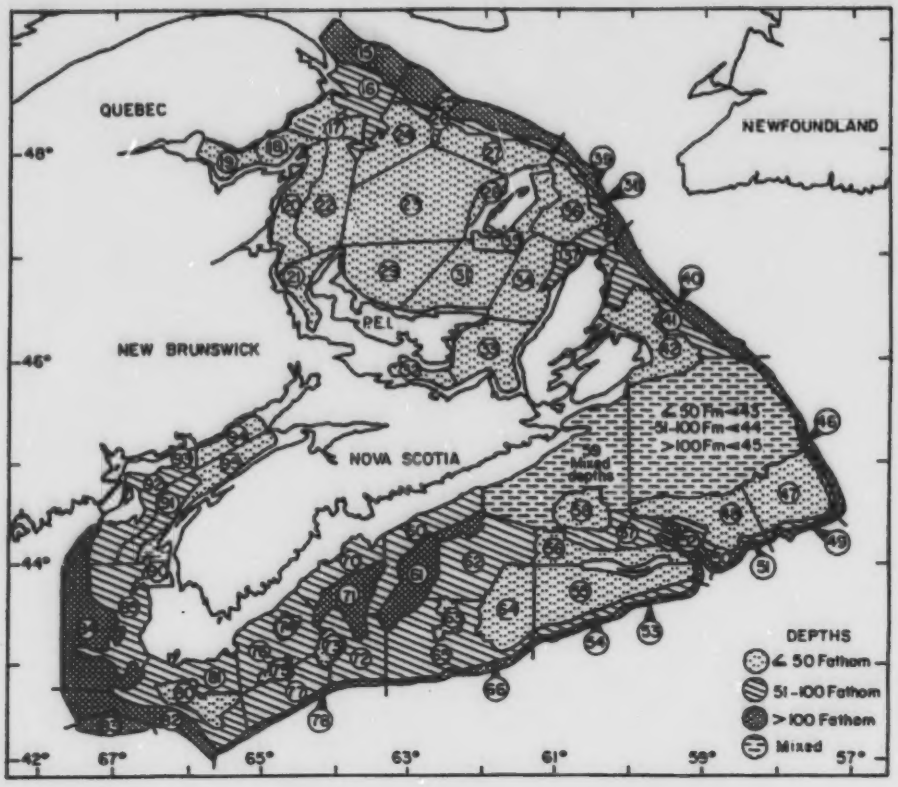


Figure 22. Groundfish survey strata in NAFO Divisions 4T, 4V, 4W and 4X (from Doubleday 1981).

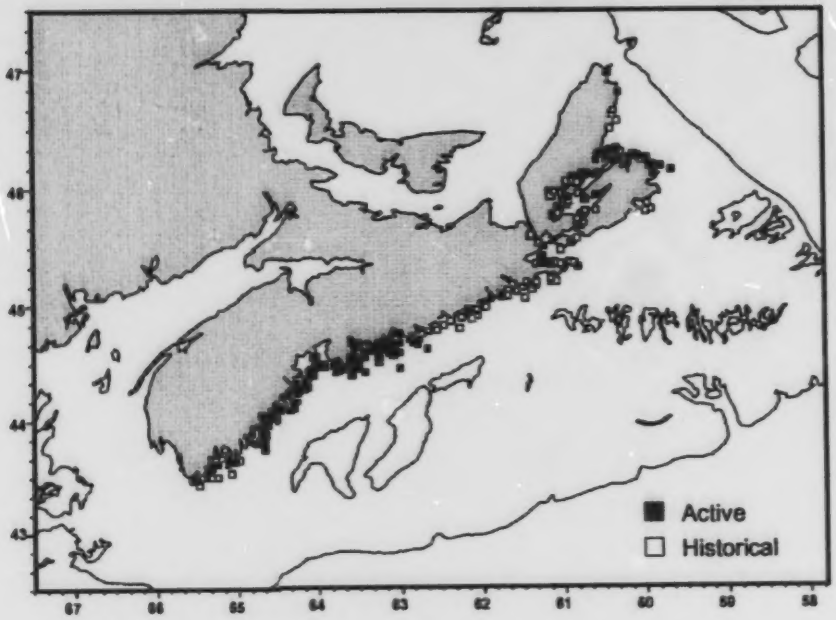


Figure 23. Map of active (closed squares) and historical (open squares) spawning locations for the Coastal Nova Scotia spawning component.

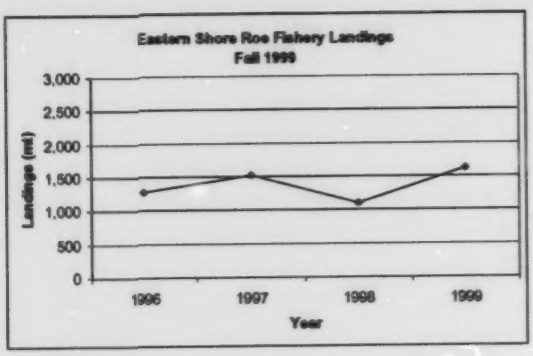


Figure 24. Yearly landings for the fall 1999 gillnet fishery east of Halifax, 1996 to 1999.

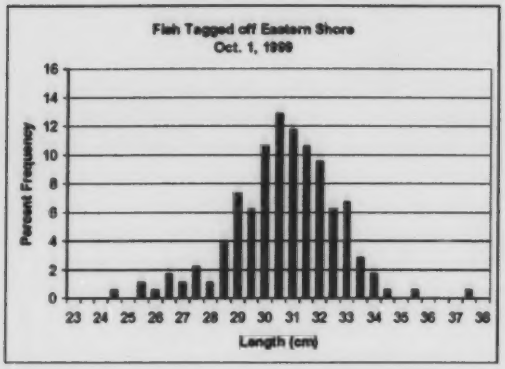


Figure 25. Length frequency of herring collected by purse seine during tagging operations off the Eastern Shore of Nova Scotia, October 1999.

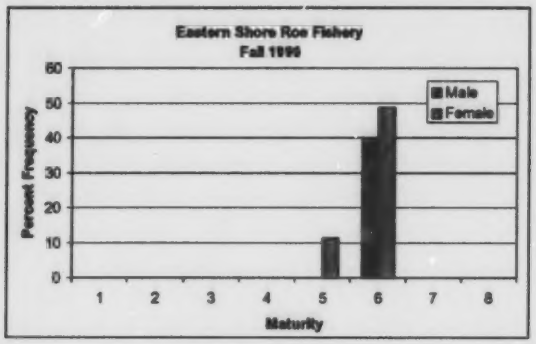


Figure 26. Maturity stages of herring collected by purse seine during tagging operations off the Eastern Shore of Nova Scotia, October 1999.

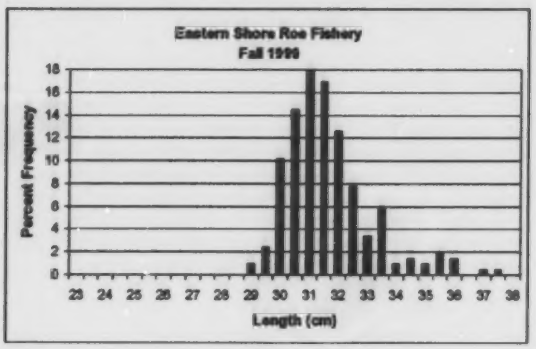


Figure 27. Length frequency of herring sampled from the 1999 fall gillnet roe fishery off the Eastern Shore of Nova Scotia.

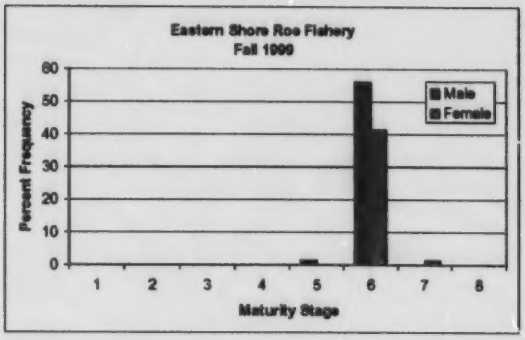


Figure 28. Maturity stages of herring sampled from the 1999 fall gillnet roe fishery off the Eastern Shore of Nova Scotia.

Figure 29. Herring catch at age (% numbers and % weight) for the fall 1999 gillnet fishery east of Halifax.

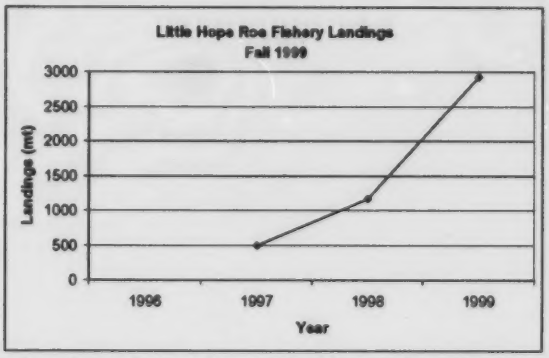


Figure 30. Herring landings foomr the Little Hope gillnet fishery, 1996 to 1999.

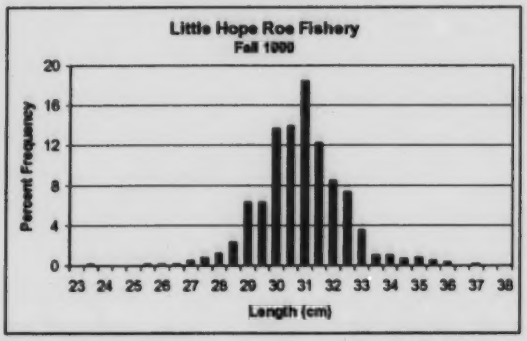


Figure 31. Length frequency of herring sampled from the Little Hope 1999 fall gillnet roe fishery.

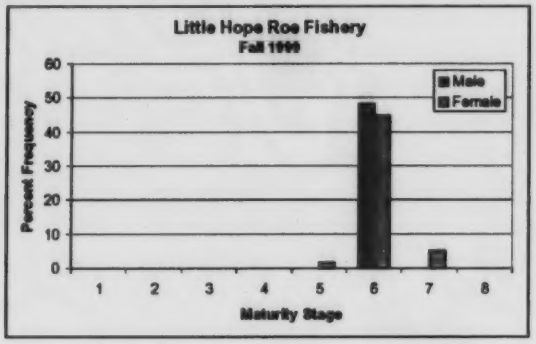


Figure 32. Maturity stages of herring sampled from the Little Hope 1999 fall gillnet roe fishery.

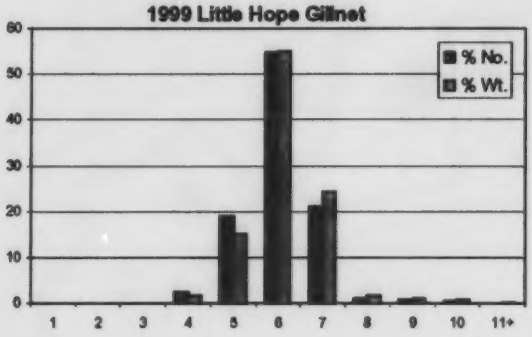


Figure 33. Catch at age (% numbers and % weight) of herring from the 1999 Little Hope gillnet fishery.

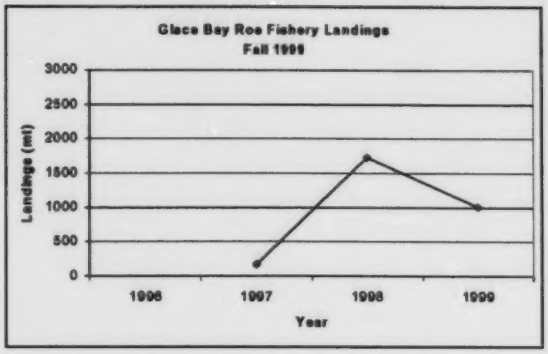


Figure 34. Landings of herring from the Glace Bay gillnet fishery, 1996 to 1999.

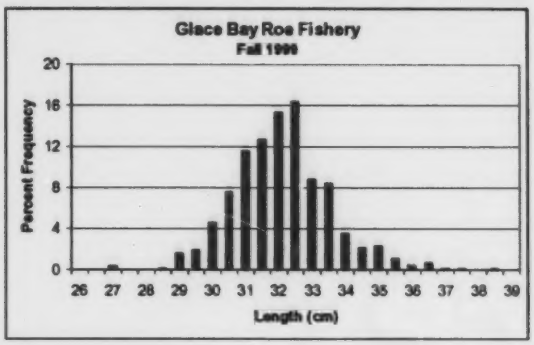


Figure 35. Length frequency of the herring sampled from the 1999 fall gillnet roe fishery off Glace Bay.

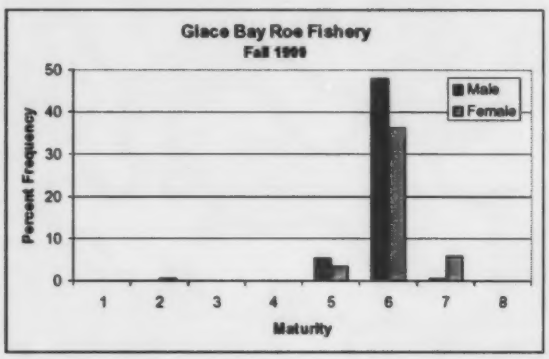


Figure 36. Maturity stages of herring sampled from the 1999 fall gillnet roe fishery off Glace Bay.

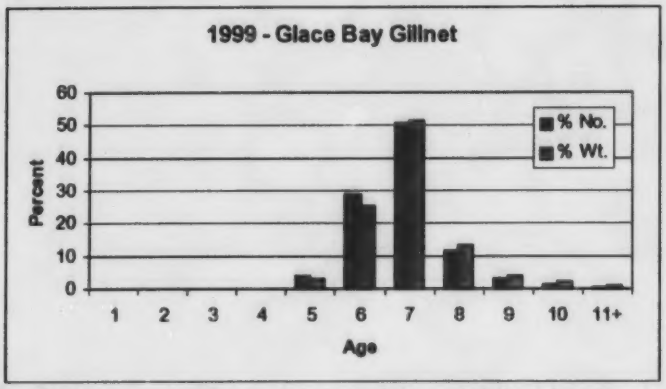


Figure 37. Catch at age (% numbers and % weight) of herring from the fall 1999 Glace Bay gillnet fishery.

Figure 38. Recorded landings of herring for the Bras d'Or Lakes gillnet fishery, 1970 to 1999. Prior to 1998 bait landings were largely unrecorded and are therefore not included in this figure.

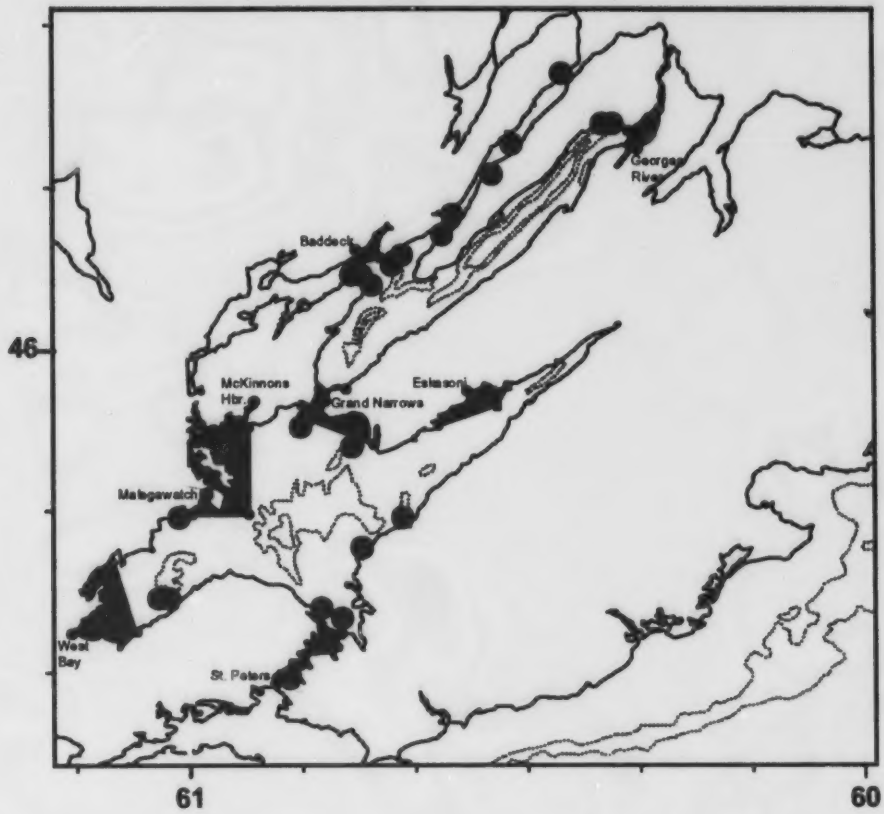


Figure 39. Closed areas (grey) and fishing locations (black circles) for the 1999 spring Bras d'Or Lakes herring fishery.

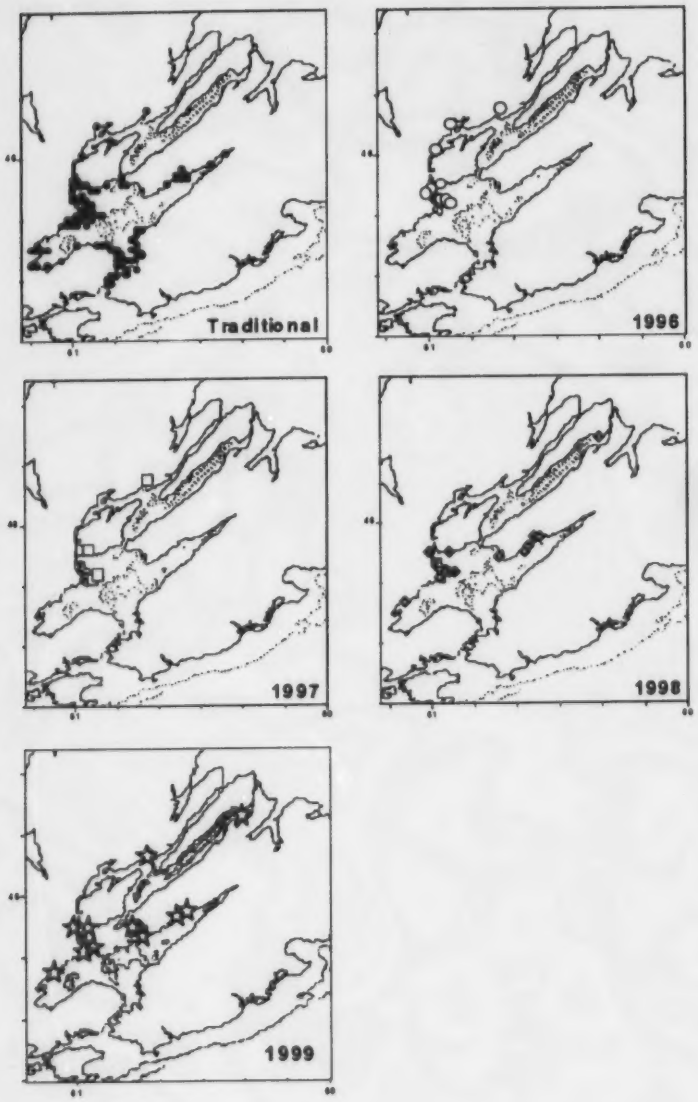


Figure 40. Traditional spawning locations and active spawning sites from the 1996 to 1999 spring herring fisheries in the Bras d'Or Lakes.

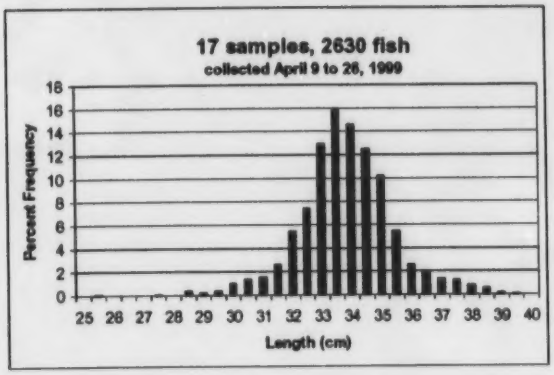


Figure 41. Length frequency of the herring sampled from the 1999 spring gillnet fishery in the Bras d'Or Lakes.

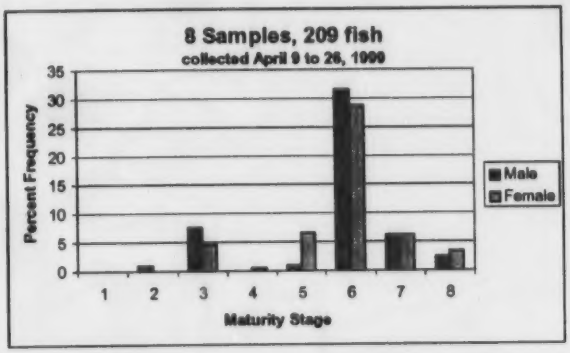


Figure 42. Maturity stages for herring sampled from the 1999 spring gillnet fishery in the Bras d'Or Lakes.

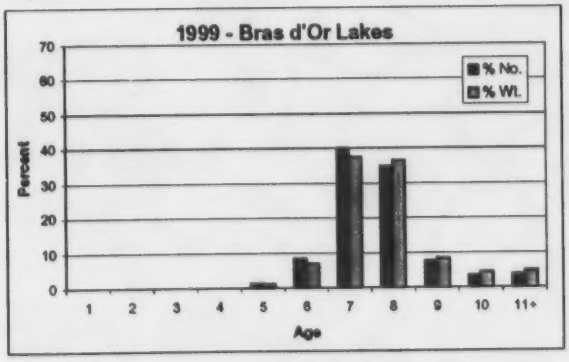


Figure 43. Catch at age (% numbers and % weight) of herring from the spring 1999 Bras d'Or Lakes gillnet fishery.

Figure 44. 1978-99 New Brunswick and Nova Scotia herring weir catches (data summed by 1 mile square).

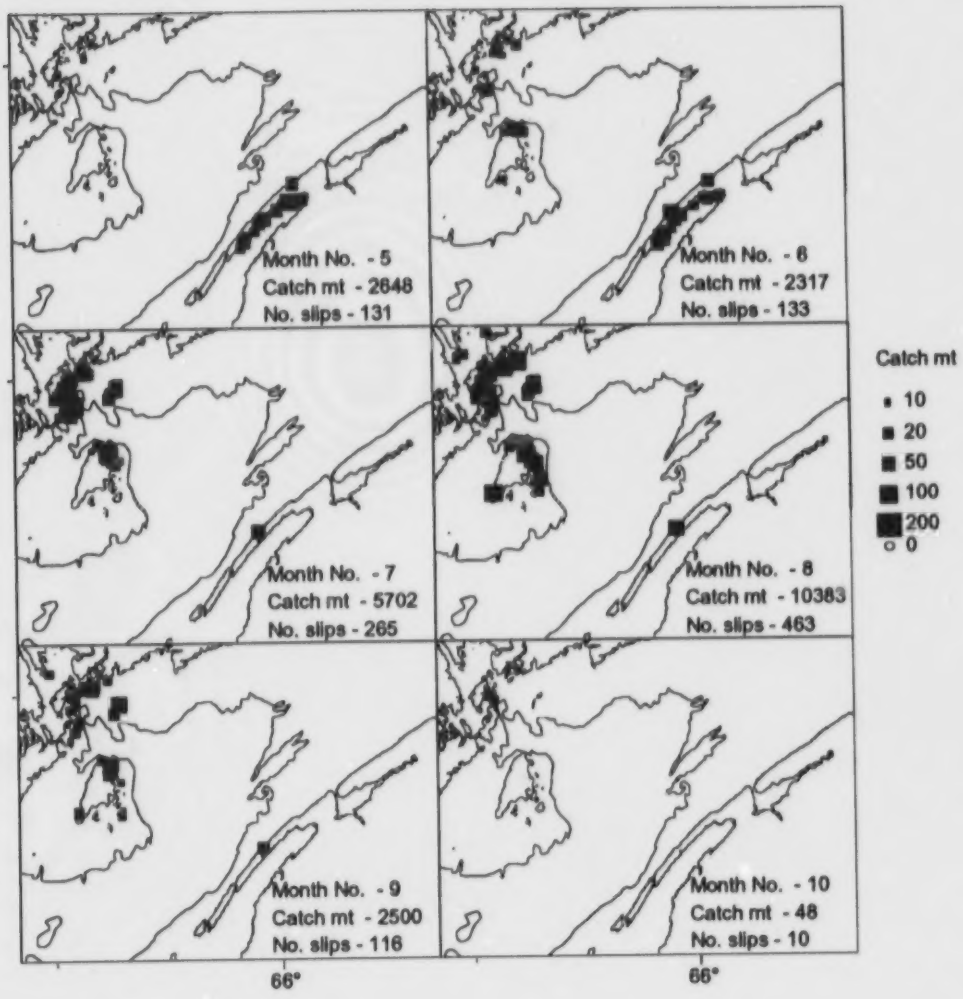


Figure 45. 1999 New Brunswick and Nova Scotia herring weir catches by month using exact weir locations.

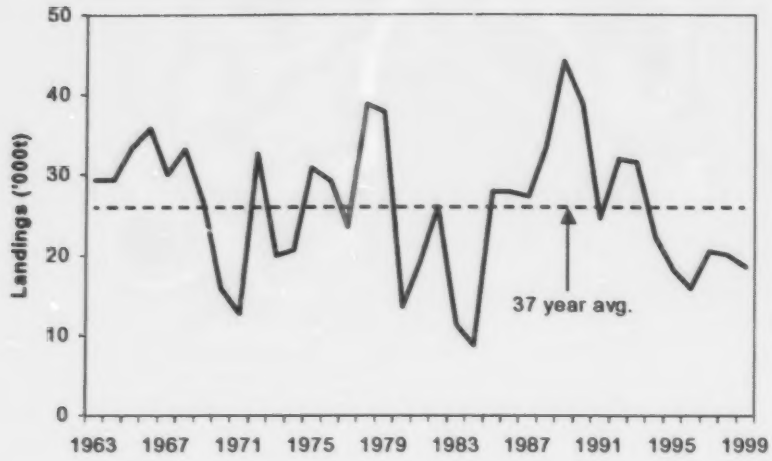


Figure 46. Herring landings from the southwest New Brunswick weir and shutoff fishery, 1963-1999.

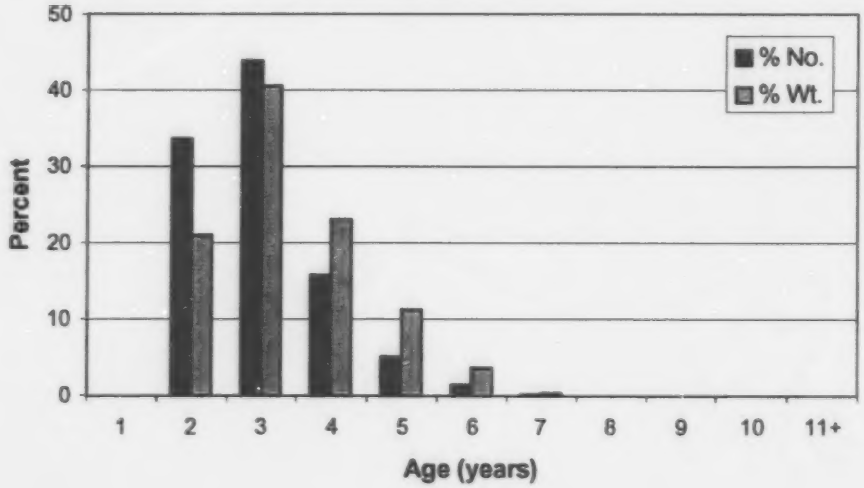


Figure 47. Catch at age (% numbers and % weight) of herring from the 1999 southwest New Brunswick weir and shutoff fisheries.

APPENDIX I: Examples of summaries of stock status indicators used previously for Scotia-Fundy herring and 5Z Herring

A. Proposed framework and biological characteristics to be used in decision making for Georges Bank (5Z) herring (from Melvin et al., 1995).

Framework for decision making

As a developing fishery, it is important to be prepared for all eventualities and to anticipate changes in the Georges Bank fishery toward realizing the extent and reliability of managing herring stocks. Of prime concern is our inability to conduct an analytical assessment of the stock in absence of an established commercial fishery. Thus it is important that a strategic decision-making process, based on biological characteristics, be established to deal with the emerging Georges Bank herring fishery

The purpose of the decision-making process will be to provide a proactive view to events in the fishery system over time. This would be accomplished through a more complete understanding of the source and extent of the evolving fishery, and its expected pattern of exploitation on the bank. An important element of the process is to set out objective criteria for explicit measurement of stock population status over time for contingent management responses and alternatives for maintaining the objectives of the plan.

Operation of the strategic plan would be reinforced by well-defined procedures for continual monitoring and feedback from the fishery, including review of the strategic objectives. The process would involve all participants in the fishery system as well as define their specific roles and contributions to consensus-building and co-management toward integrated decision making for stock evaluation.

As a starting point in this process, we present a list of biological characteristics which during the course of time, have demonstrated changes that appear to correspond with changes in stock abundance. The following characteristics and their levels are listed as an example of how we might evaluate such changes and upon which a pre-determined criteria for action can be established. Positive values have intentionally been set such that the 1994 criteria values signal encouragement in a general sense. Further work is required to define the specific range for each of the criteria.

Criteria	Negative	Signal Neutral	Positive
Research Surveys:			
Larval Abundance Index	<20/m	20-40/m2	>40/m2
Larval Coverage	<40% Can	40-60%	>60%
Spawning Coverage	<25% Can	25-40 %	>40%
US Bottom Trawl Index (Weight)	<2kg/tow	2-3.5Kg	>3.5Kg
US Bottom Trawl Index (Number)	<10/tow	10-20	>20
Adult Distribution (define Area)	<40%	40-60	>60%
Recruitment (age 3-4)	<50%	50-60	>60%
Mean Length @ age 3	>26cm	25-26	<25cm
Mean Length Imm age 3	>25.5	24.5-25.5	<24.5cm
% mature at age 3	>65%	45-65%	<45%
Industry Observations:			
To be developed.			

Once the criteria and their ranges have been established, the data can be put into a decision matrix which has pre-determined levels of action regarding the stock status and harvest options. One might imagine, in the simplest form, the following;

All Negative ——————→ Reduction in recommended catch level

Mixed ——————→ Status Quo

All Positive ——————→ Increase in recommended catch level.

B. Table 1a. Biological considerations used in 4WX herring fishery in-season decision making (from Stephenson et al., 1996)

	Positive	Negative
Spawning areas		
Times	Normal	Late or early
Location	All traditional areas	Missing in expected locations
Relative Amount	> or as expected	Few
Size (age) composition		
Compare with average # at size	High abundance of large (4+ or >26 cm) fish + reasonable presence of smaller fish	Narrow age span; missing year-classes
Distribution		
Distributed as expected from previous years	Presence in all expected areas (last 10 years)	Missing in some expected areas
Relative Abundance		
Observation and fishing success in expected areas	Lots of fish observed; high proportion of vessels with successful sets/trips; positive cumulative catch	Lack of sets; unsuccessful nights; few fish; small catches
Behaviour		
Fish behaviour as related to fishing success, and in relation to previous experience	Lots of fish- but too deep/shallow or avoiding gear	Fish acting abnormally; only small, scattered bunches seen
Physiology/condition		
Condition as related to previous years	Feeding and high fat content at appropriate times	Abnormal conditions of fat content and feed (as in '94); high proportion of small fish (<25.5cm) mature
Environmental info		
Water temp, salinity, plankton abundance		

Rob Stephenson
Modified August 25, 1995

C. Table 1b. Summary of biological checklist for 1994-95 4WX herring fishery (indicators: + is a positive change, - is a negative change, ? is unclear or unknown) (From Stephenson et al., 1996)

	N.S. Winter	N.B. Winter	Early pre-spawning	Scot's Bay	Trinity Ledge	Gannet/ Dry Ledge	Seal Island	German Bank	No. of +	No. of ?	*No. of -*
Spawning –area				+	+	+		+	4	0	0
-location				+	+	+	-	+	4	0	1
-amount				-			-	-	0	0	3
Size and Age	-	?	?	-	+	+		-	2	2	3
Distribution	-	?	-						0	1	2
Abundance	-	?	-	?	-	?	-	?	0	4	4
Behaviour				?	?	?	-		0	3	1
Physiology	-		+	-					1	0	2
No. of +	0	0	1	2	3	3	0	2	11		
No. of ?	0	3	1	2	1	2	0	1		10	
No. of -	4	0	2	3	1	0	4	2			16

D. Examples of checklist narrative: used on both non-spawning (A) and spawning (B) herring fisheries. (from Stephenson et al., 1996)

(A) Biological checklist: Early summer feeding and pre-spawning aggregations

- size/age composition: good on Browns Bank (+), but dominated by young fish (age 3) inshore (-)
- distribution: less than expected from traditional feeding areas south of Yarmouth (-)
- relative abundance: less large fish than usual throughout the area (except near Browns Bank early in the season) (-); higher proportion of small fish than expected, especially along Long Island shore.
- physiology/condition: normal; no sign of low fat or lack of feed seen in 1994 (+)

(B) Biological checklist- Gannet/Dry Ledge

- spawning time normal; ripe fish Aug. 23 to 28, some hard fish remaining (+)
- spawning location: normal on Gannet (+)
- size/age composition: good age distribution from Gannet; desirable proportion of older ages (+)
- relative abundance: recognition by industry that this was not a large spawning group resulted in a restriction of catch
- behaviour: normal in the Gannet area

Biological checklist- Seal Island

- spawning location: little observed at Seal Island (-)
- size/age composition:
- relative abundance: absence of documented spawning at Seal Island is cause for concern (-)
- behaviour: absent at Seal Island (-)

D. Example of criteria for in-season decision making (from DFO, 1997).

In-season Management in the 4WX Herring Fishery

Criteria for in-season decision making

The monitoring Working Group met routinely in person or by conference call to review new information and come to some agreement on a course of action. A structured decision making process was required and this necessitated better monitoring and acquisition of new data, rapid compilation of information, and development of an appropriate decision making forum.

As much of the concern was for the biological state of the fishery, the accompanying table was used as the framework for discussion. The table which lists biological information that could be expected during the fishery-and signs that would be considered positive or negative- was used as the basis for achieving consensus on whether the signals from the fishers were as expected, prior to decision making. Biological considerations for 4WX herring fishery in-season decision making

OBSERVATION	POSITIVE	NEGATIVE
Spawning time	Normal	Late or early
Spawning Location	Traditional areas	Not as expected
Spawning relative amount	More than previous years	Less
Size, age composition	Broad age span with younger recruiting year classes as well	Narrow age span; missing year classes
Distribution of fish	Presence in expected areas	Missing in expected areas
Relative fish abundance	Lots of fish and good catch rates and trip success	Few fish; lack of sets; low catch rates
Fish behaviour	As related to fishing success and previous experience	Fish acting abnormally
Physiology/ condition	Usual feeding and fat content at appropriate times	Abnormal conditions of feed and fat for the time and place
Environmental factors	Water temp, salinity, plankton abundance	Differences from previous years?

Appendix 2: Fleet Activity in the 1999 4WX Herring Fishery.

S. Arsenault
Pelagics Research Council

The following summary of the 1999 4WX herring fishery was compiled from Dockside Monitoring Program logbooks, industry records, vessel search records and the observations of the Pelagics Research Council (PRC) and Department of Fisheries and Oceans (DFO) staff. It shows the overall distribution of fishing activity for the purse seine and gillnet fleets (Fig. 1-4) as well as on a weekly basis (Fig. 5-8) in relation to three major spawning components: the Scotian Shelf, South West Nova Scotia and Coastal Nova Scotia. It attempts to document the changes and trends that occurred within each major fishing area during the season and also documents the mapping and acoustic survey activities during the 1999 fishery (Table 1).

Numerous groups and individuals have contributed and participated in documenting the fishery during the 1999 season. This has provided valuable information on fishing activity, herring stocks and spawning groups within 4WX. The quality and amount of information is a product of the time and dedication of all involved.

Offshore/Scotian Shelf Banks

Summary

- Reactivated fishing area since 1996
- The 1999 Offshore/Scotian Shelf purse seine fishery took place between May 25th and June 17th, a slightly shorter season then the last three years.
- 1999 fishing activity focused largely on the Patch and the Bullpen. This was similar to the 1998 season (the Patch and Emerald Basin) but unlike the 1997 season (fished several banks).
- Landings in 1999 (12,645t) were higher than 1998 (5,579t) but were lower then 1997 (20,261t).
- Early in the season fish stayed deep and were hard to catch but by the end of the season fish started bunching and coming to the surface.

1999 Fishing Weeks

May 21 – May 27 (Fig. 5: Week 21)

Five boats were on the Patch this week. A total of 7 landings were made between May 25th and May 27th with most vessels fishing for one to two nights. Fish in this area were large but contained some red feed (range 26.5 – 33.0cm, mode – 30.5cm). School sizes were reported as "nice" but the fish were tricky to catch. The fish stayed deep most of the night but fishing was good at daylight. One vessel reported a water temperature of 49.2°F.

May 28 – June 3 (Fig. 5: Week 22)
There were 15 boats on the Offshore Banks, concentrating their efforts on the Patch and the Bullpen. There were 30 landings reported (2,091t) this week with most vessels fishing for three days. Fish were reported as staying deep and close to bottom and when they came to the surface they were hard to catch.

June 4 – June 10 (Fig. 5: Week 23)
Several boats remained on the Patch and the Bullpen. The captains reported seeing fish of a good size that came to the surface at dark. The plants reported that fish were 12 – 13% fat and of good quality. An automated acoustic and mapping survey was conducted on the Patch on June 10th, involving DFO science and 7 purse seine vessels. The mapping survey recorded 22,585t and the acoustic survey recorded 22,347t of fish.

June 11 – June 17 (Fig. 5: Week 24)
Ten boats remained on the Patch this week. Most of the boats were here for 4 to 5 nights; all landed significant loads totaling 1,987t. Fish on the Patch ranged in size from 21.0 – 38.5cm with a mode of 32.0cm, and fish from the Bullpen ranged in size from 21.5 – 36.0cm with a mode of 30.0cm. One vessel reported that the water temperature was 55°F this week. All of the boats moved to different fishing grounds by the end of the week.

South West Nova Scotia

Summary

- This fishery was similar in location and timing to previous years, with the exception of the German Bank fishery that started slightly earlier.
- The purse seine fleet concentrated their efforts on prespawning (Long Island Shore, Grand Manan Banks, Trinity Ledge) and spawning (Scots Bay, German Bank) aggregations.
- The gillnet fleet concentrated their efforts on traditional grounds (Spectacle Buoy, Trinity Ledge).
- Landings totaled 74,700t for 1999 (73,087t purse seine and 1,613t gillnet)
- Dogfish were unusually abundant on the fishing grounds compared to recent years.
- Herring present on traditional summer feeding grounds.
- Spawning occurred at the usual times on German Bank, Trinity Ledge and in Scots Bay, but did not at Seal Island. There were no surveys of Spectacle Buoy.

1998 Fishing Weeks

October 15 - October 21 (Fig. 5: Week 42)
Thirteen vessels concentrated their fishing efforts on Grand Manan, most fishing 4 nights, landing 691t. Captains reported seeing lots of fish which stayed deep. One

vessel visited Long Island Shore twice during this week, landing a total of 27t. This was the end of the purse seine fishing effort on the Long Island Shore until next season.

October 22 – October 28 (Fig. 5: Week 43)
Ten vessels fished out of Grand Manan for a couple of nights this week. At the start of the week fish thinned, spread out and stayed deep. A total of 1,019t of fish were landed from Grand Manan this week.

October 29 – November 4 (Fig. 5: Week 44)
Fourteen vessels fished near Grand Manan for a couple of nights, landing 333t of fish. Herring were scarcer this week and there were a lot of mackerel in the schools.

November 5 – November 10 (Fig. 5: Week 45)
Two boats fished near Grand Manan this week. There were still reports of mackerel mixed in with the herring schools. There was a full moon this week and the fish stayed deep. The fish thinned out considerably by the end of the week. Landings of 145t were reported for this week. This ended the fishery on Grand Manan until spring.

1999 Fishing Weeks

April 16 – April 22 (Fig. 5: Week 16)
The spring fishing season started around the 18th of April with one vessel landing herring from German Bank for the bait market. Small landings were reported this week. Captains reported small fish in their log books.

April 23 – April 29 (Fig. 5: Week 17)
Four boats landed approximately 260t of fish from German Bank for the bait market. There were 3 fishing nights this week, with low landings. Captains reported observing small fish.

April 30 – May 6 (Fig. 5: Week 18)
Three boats were on German Bank on May 1st but they only stayed one night, landing 180t. One vessel was off Grand Manan for one night and landed a load of fish. Later in the week the boats moved to the Long Island Shore where they stayed for a couple of nights, landing a total of 357t. Fish were reported as being scattered and deep.

May 7 – May 13 (Fig. 5: Week 19)
There was only one fishing night this week Three boats fished off the Long Island Shore on May 7 and landed 62t of fish. Market demands were low, which could explain the low landings.

May 14 – May 20 (Fig. 5: Week 20)
Four boats were on Browns Bank at the beginning of the week, landing 266t. These 4 boats then moved to the Western Hole for two nights and landed 630t. The fish were reported as "feedy" and were in small bunches. In the middle of the week one boat

landed a small amount of fish from Gannet Dry Ledge and a load from German Bank. As well, 2 boats visited the southwestern grounds for 2 nights landing a total of 170t. Nine boats fished off of Grand Manan, landing 799t of fish. Most of the boats landed 2 to 4 loads of fish this week. Fish from Grand Manan came to the surface before dark, thinned out, and then broke into small bunches.

May 21 – May 27 (Fig. 5: Week 21)
Four boats fished near Grand Manan, landing 212t of fish. Two boats landed 56t of fish from the Long Island Shore.

May 28 – June 3 (Fig. 5: Week 22)
Five boats fished off the Long Island Shore, recording 6 landings totaling 133t. Most boats fished one night and then moved to Grand Manan. By the end of the week, 15 boats were on Grand Manan fishing for up to 3 nights and landing 822t. Fish in this area were spread out, stayed close to bottom and were described as being a little "feedy". Some mackerel were mixed in with the herring schools and there were a lot of whales around. One boat was on the South West Grounds and landed two loads totaling 171t.

June 4 – June 10 (Fig. 5: Week 23)
Twelve boats fished between Grand Manan and the Long Island Shore. There were a total of 32 reported landings, totaling 1,192t from Grand Manan. Nine landings, totaling 167t, were made from Long Island Shore this week. On June 4th, the fish in this area were reported as being of mixed sizes and were hard to catch. Sets were made in approximately 36 fathoms of water. The weather was bad on the 7th and 8th which made fishing difficult.

June 11 – June 17 (Fig. 5: Week 24)
Fourteen boats fished from Grand Manan, landing 1,359t of fish. The boats fished anywhere from 2 to 5 nights this week. Four boats visited the Long Island Shore, catching 167t of fish. Fish from Grand Manan and Long Island Shore were reported as being of mixed sizes but there were a lot of large fish. Fishers also reported an increase in school sizes this week. Four boats were on the southwestern grounds for one night, June 14th. All four boats caught a load and landed 408t of fish. A lot of fish were in the area but they were present in small bunches and they stayed deep. Fishing efforts were concentrated around the Tusket Basin.

June 18 – June 24 (Week 25)
There was a lot of fishing activity this week and weather was good. Five boats visited Browns Bank for one night, each catching 303t. There was a large amount of herring on Browns Bank but there were also strong tides that affected the fishing effort. Fish were distributed into small schools. Seven boats visited German Bank later in the week and fished an average of 3 nights each. There was not much fish on German this week but the market quality was good. Fish were reported as big, with 14% fat content and no feed. A total of 1,133t of fish were landed from German Bank this week. Three boats fished for one night off Grand Manan on June 18th, catching 73t of fish. Fish

were scarce in this area so the boats moved to the Long Island Shore. Twelve boats fished off the Long Island Shore spending 3 to 4 nights each and landing 1,218t. There was a significant amount of herring but they were spread out and present only in shoal water. Fishing efforts were concentrated at daylight when the fish moved off shore. The herring were of mixed sizes and were full of hard roe. Twelve boats visited the Southwestern Grounds for a couple of nights, landing 2,066t of fish. There was a trace of feed in the herring from this area but the fish were large and aggregated in bunches. At the end of the week, five boats visited Seal Island for one night, landing 353t of fish. One vessel visited Trinity Ledge on June 18th and landed a small load of fish. At the beginning of the week, two vessels spent a couple of days on the Western Hole, landing significant loads. A small load was landed from Yankee Bank June 21st. The fish were of mixed sizes.

June 25 – July 1 (Fig. 5: Week 26)
During this week, three boats spent one night each on Browns Bank, landing 159t of hard roe fish. According to the plants, the fat content was between 20 – 25%. One vessel visited Gannet Dry Ledge on June 28th, catching a small load. Five boats were on German Bank for one night, landing 227t. Fish were observed in small bunches and were moving fast. 227 tons of fish were landed from German Bank. Two vessels fished off Grand Manan on June 29th and caught 50t of fish. Nine boats spent 2 to 4 nights off the Long Island Shore, catching 1,216t of fish. Log reports state that there was a huge amount of fish seen at the beginning of the week but they had thinned out by July 1st. The fish were still staying close to shore and were of mixed sizes. Fourteen boats spent 1 to 2 nights on the Southwestern Grounds, landing 1,158t of fish. There was a lot of fish in the shoal water but they were broke up into little schools. One vessel fished off Seal Island for one night on June 25th and caught a small amount of fish. A mapping survey was scheduled for June 28th on Spectacle Buoy but was cancelled due to bad weather.

July 2 – July 8 (Fig. 5: Week 27)
At the beginning of the week, 17 boats were on German Bank. They stayed a couple of nights and landed 1,807t of fish. The fish plants reported that the fish were too small. The fish on German were mixed in sizes and not what the plants wanted. Captains reported that there were a lot of fish around this week but they were hard to catch. On July 7th, a school of 5 – 6 miles in length was observed. These 17 boats moved to the Gannet Dry Ledge towards the end of the week and stayed for 2 to 3 nights, landing 1,816t. The fish from this location had a bit of feed in them and were of mixed sizes. One vessel fished off Grand Manan for two nights this week, landing 29t. Ten boats were off the Long Island Shore, landing 965t of fish. Most of the boats stayed 4 nights. Captains reported that the fish were late coming off the shore this week because of the full moon. A mapping survey was scheduled for July 5th on Spectacle Buoy but was cancelled by industry.

July 9 – July 15 (Fig. 5: Week 28)
Seventeen boats were on Gannet Dry Ledge again this week, staying 3 to 5 nights and landing 3,734t. The fish were reported as being big and in large bunches. Some

dogfish were present in the catches. Three boats visited German Bank for one night each, landing 142t. Eleven boats were off the Long Island Shore for most of the week landing 1,091t. Captains reported seeing good bunches of small fish this week. They felt that the larger fish had moved on and the remaining fish were smaller and full of feed. One vessel visited Lurcher on July 13th.

July 16 – July 22 (Fig. 5: Week 29)
No fishing occurred on July 17th and 18th. Fourteen boats visited Gannet Dry Ledge for a night or two and landed 1,011t of fish. Captains reported that there was still a lot of fish on the Dry Ledge but they were spread out along the surface. The boats left by July 22nd to fish on German Bank. Nineteen boats were on German Bank by the weekend, landing 2,716t. The weather was clear and calm on German this week. There was a lot of fish in the area but some were full of feed. Twelve boats concentrated along the Long Island Shore for 4 to 5 nights, landing 1,128t. The fish were small, 8 – 12 inches, and were full of hard roe. They were tricky to catch, as they stayed in shallow water until daylight. On July 21st, one vessel visited Yankee Bank and landed a load of fish. Four boats visited Scots Bay around July 22nd, landing 188t. Captains commented on the large amount of dogfish in the area which were often seen in groups, breaking the surface of the water. The dogfish interfered with fishing efforts. Fish were reported as being caught at depths of 14 fathoms this week.

July 23 – July 29 (Fig. 5: Week 30)
Fourteen boats concentrated their efforts on Gannet Dry Ledge for 3 to 4 nights at the beginning of the week, landing 2,376t of fish. At the beginning of the week the weather was bad and hindered fishing. Fish schools were mixed in sizes and contained a lot of dogfish. Towards the end of this week, 4 boats moved to German Bank and caught 439t. Captains reported that fish were either caught right at dark or not at all. Eleven boats fished off of the Long Island Shore for about 4 nights, landing 945t, although the fish were still staying close in to shore. At the beginning of the week, the fish in Scots Bay were plentiful and a mixture of mature and immature fish but by the end of the week most all of the fish were mature. Five boats were in Scots Bay and they landed 821t. The DFO research vessel, the J.L Hart, conducted surveys on July 25th and 26th using the portable acoustic system, recording 1,166t of fish.

July 30 – August 5 (Fig. 5: Week 31)
One vessel landed a small load of fish from Gannet Dry Ledge this week. Weather seemed to be a factor, with most boats not fishing on the August 1st and 2nd. Seventeen boats fished on German Bank for 1 to 3 nights, landing 1,749t. Big fish were seen but the roe was still hard and captains believed it will be another couple of weeks before the roe would be ready. Eleven boats fished off the Long Island Shore on August 3rd, 4th, and 5th catching 945t. The fish off the Long Island Shore were bigger this week but were still staying close to shore. A survey using one vessel with an automated acoustic system was conducted in Scots Bay on July 30th and August 1st. A few hundred tons of fish were recorded in this area. Three boats were in Scots Bay between August 2nd and 4th, landing 288t. There were still lots of herring but they were mixed with dogfish. One vessel landed 40t of herring from Seal Island on August 4th.

There were five boats on Trinity Ledge on August 4th and 5th, landing 246t. These were the first significant landings from Trinity Ledge this season. Captains reported lots of fish on Trinity Ledge this week but only half of them were roe fish.

August 6 – August 12 (Fig. 5: Week 32)
Ten boats fished on Gannet Dry Ledge at the end of this week, landing 402t of fish. The herring were in small bunches, and were mixed with dogfish. Two vessels visited German Bank and landed 128t. Eleven Boats concentrated along the Long Island Shore for several night, landing 927t. One boat fished on the Southwestern Grounds on August 11th and caught one load. Two surveys were conducted in Scots Bay using a vessel with an automated system, which recorded 8,282t on August 8th and 1,629t on August 9th around Isle Haute. Another survey involving 3 boats was conducted in Scots Bay on August 10th. The portable acoustic gear recorded 4,800t of fish and the mapping survey recorded 23,923t of fish in the area. 1,034 fish were tagged after the survey was conducted. One PRC employee tagged again on the 12th, applying 457 tags. Five boats fished in Scots Bay for a couple of nights, landing 394t. Captains reported unusually large amounts of dogfish and suggested that this occurs every couple of years. Two vessels were on Trinity Ledge and landed 48t. The gillnet fishery started on Trinity Ledge this week, involving 18 to 20 boats.

August 13 – August 19 (Fig. 5: Week 33)
One vessel fished on Gannet Dry Ledge on August 17th, landing 23t. This vessel, along with nine others, moved to German Bank, where they remained for the rest of the week, landing 491t. PRC staff reported a number of whales in the area. Captains reported that fish stayed deep and about half of them were full of ripe roe. This week was the start of the German Bank roe fishery. Six boats were off the Long Island Shore for 2 to 3 nights from August 17th to 19th, landing 228t. Most of the captains waited until daylight to set because the fish were staying close to shore. Three vessels remained in Scots Bay this week, fishing only a night or two at the beginning of the week and landing 98t. These vessels left by August 17th largely because of the number of dogfish. This was the end of the fishery in Scots Bay for the season. The gillnet vessels continued fishing on Trinity Ledge.

August 20 – August 26 (Fig. 5: Week 34)
At the beginning of the week, three boats fished on Gannet Dry Ledge for one night, landing 30t. Thirteen boats fished on German Bank for one night on August 23rd, catching 536t. The fish on German Bank contained hard roe and stayed deep. Fish were either caught at first dark or not at all. Twelve boats concentrated their efforts along the Long Island Shore for around 3 to 4 nights, landing 1,023 t. These fish were full of red feed. Captains reported that due to a full moon the fish scattered when they moved off the shore at night. Two vessels were off Seal Island on August 24th and 25th, landing 55t. The weather was clear and calm but the fish stayed deep. A survey involving 6 boats was conducted in Scots Bay on August 20th. A total of 10381t were recorded. There were 1,476 herring tagged following this survey. The gillnet vessels continued fishing on Trinity Ledge.

August 27 – September 2 (Fig. 5: Week 35)
Two vessels fished on Gannet Dry Ledge towards the end of the week, landing 87t. Captains reported a large amount of fish in the area but these fish stayed deep. Two surveys (involving both the automated acoustic and mapping systems) were conducted on German Bank and Trinity Ledge on August 27th. Two gillnet vessels recorded 1,875t on Trinity Ledge using the portable acoustic system. Five vessels were involve in the survey of German Bank, recording a total of 27,222t. Thirteen boats were on German Bank from August 30th to September 2nd, landing 1,380t of small roe fish. There were a significant number of breaching whales in the area. Fifteen boats fished along the Long Island Shore for 3 to 4 nights, landing 1,084t. Market conditions favored larger fish this week. Two boats explored Browns Bank on the September 1st but did not see any fish. The gillnet vessels continued fishing on Trinity Ledge.

September 3 – September 9 (Fig. 5: Week 36)
A survey was conducted in Scot's Bay on September 3rd involving three boats. No herring was recorded. Two vessels were on Gannet Dry Ledge for one night each between September 7th and 9th, landing 68t. Sixteen boats were on German Bank during the latter part of this week, landing 2,425t of roe fish. Captains reported a lot of fish containing roe on German Bank. These fish stayed deep and were fished at 33 fathoms. A water temperature of 55 °F was reported for German Bank this week. Eight boats fished along the Long Island Shore, landing 534t. There were reportedly still lots of fish in the area but they were staying close to shore or deep in the water column. A survey of Trinity Ledge involving 8 gillnetters was performed on September 9th, recording 2,010t. The gillnet vessels continued fishing on Trinity Ledge.

September 10 – September 16 (Fig. 5: Week 37)
No fishing occurred on September 11th and 12th and only a few boats fished along the Long Island Shore on September13th. Two vessels returned to Gannet Dry Ledge on September 10th, landing 101t. Thirteen boats were on German Bank this week, fishing about 2 nights and landing 1,053t. A survey involving one PRC staff member and 6 vessels was conducted on September 10th, recording a total of 40,991t. Captains reported good bunches of roe fish here all this week. The presence of dogfish hindered fishing efforts this week. Fish were caught in 30 fathoms of 55°F water. Eleven boats fished along the Long Island Shore for an average of 2 to 4 nights in the latter part of the week, landing 836t. Herring schools were thin, deep and contained fish of mixed size. Five boats fished on Trinity Ledge from September 14th to 16th, landing 296t. Fish in this area were reported as being in big bunches but they stayed deep. These fish contained hard roe and were sold as bait. A survey of Trinity Ledge was scheduled for September 13th but was cancelled due to weather. The gillnet fishery ended on Trinity Ledge on September 16th, landing a total of 1,147t.

September 17 – September 23 (Fig. 5: Week 38)
No fishing occurred between September 17th and 19th. Six boats were on Trinity Ledge from September 20th to 23rd. They landed 354t of herring which were reported as being full of ripe roe. Eight boats fished along the Long Island Shore for a night or two

towards the end of the week, landing 240t. Captains reported large amounts of herring with some mackerel mixed in with the herring schools. Only one landing of 61t was made from the Gannet Dry Ledge on September 22nd. Eighteen boats fished on German Bank on September 20th and 23rd, landing 3,478t. These fish were full of good quality roe but were hard to catch because they moved to deeper water when the seine was set. There were still reports of a lot of whales in the area. A PRC staff member tagged fish for two nights on September 21st and the 22nd, applying 814 tags.

September 24 – September 30 (Fig. 5: Week39)
No fishing occurred on September 24th and 25th. Two vessels returned to Gannet Dry Ledge for one night each between September 27th and 29th, landing 101t. Most of the fleets fishing efforts were concentrated on German Bank, with 22 boats fishing for 3 to 4 nights and landing 5,622t. Captains reported large amounts of herring but half of them contained hard roe. There was also a large amount of dogfish on German Bank. A survey involving 5 vessels was conducted on German Bank on September 25th, recording 11,528t. The weather was unfavorable for setting the seine so no tags were applied. Nine boats fished along the Long Island Shore for a few nights at the end of the week, landing 842t. There was reportedly a large amount of mackerel mixed in with the herring schools this week. Two vessels were on Trinity Ledge towards the end of the week and landed 245t. These boats fished on McDormand Patch and reported that the herring were a nice size and full of good roe. A survey of Trinity Ledge was scheduled for September 24th but was cancelled due to unfavorable weather conditions.

October 1 – October 7 (Fig. 5: Week 40)
No boats fished on the October 1st. Six boats fished on Browns Bank for one night on October 4th and landed 664t. Captains reported seeing large schools of herring but there was a mixture of fish with ripe and hard roe. Fish were being caught in 33 fathoms at a water temperature of 56 °F. Some boats returned to Browns Bank on October 6th but the weather was too poor for fishing. One vessel was on Gannet Dry Ledge on the October 4th, landing of 135t. This ended the fishery on Gannet Dry Ledge for this season. Eight boats fished on German Bank on October 2nd and 6th, landing 514t. Most boats only fished for one night except for one vessel which fished for two nights. A survey involving a DFO research vessel, the J.L. Hart, was conducted on German Bank on October 2nd. No fish were observed during this survey. Nine boats fished off Grand Manan between the October 4th and 7th, landing 1,062t. Fish from Grand Manan were reported as small and were mixed with mackerel. No large schools were seen this week. Fourteen boats fished along the Long Island Shore for 2 to 4 nights, landing 1,274t. There were reports of feed in these herring. They were sold for food and bait. Two vessels visited coastal New Brunswick between October 4th and 6th and landed 60t. One boat fished on Trinity Ledge for one night on October 6th and landed 52t. This ended the fishery on Trinity for the season.

October 8 – October 14 (Fig. 5: Week 41)
One vessel fished on Browns Bank for one night on October 11th, landing 43t. This ended the fishery on Brown's Bank for the year. Two vessels fished on German Bank for one night each between October 9th and 11th, landing 178t. A survey involving one

PRC member and one vessel was conducted on German Bank on October 8th, recording 3,900t of herring. Four vessels remained fishing off Grand Manan, landing 151t. Captains reported that the schools of herring off Grand Manan were thin, deep and mixed with mackerel. Seventeen vessels concentrated their efforts along the Long Island Shore, landing 2,497t. The herring were small and sold for bait. One of the vessels reported a water temperature of 55 °F and fish were caught in 35 fathoms. Captains reported the roe was hard.

October 15 – October 21 (Fig. 6: Week 42)
Two vessels were on German Bank this week for up to three nights, landing 170t. This ended the fishery on German Bank for this year. Nine vessels were off Grand Manan, landing 616t. Nine vessels were along the Long Island Shore and landed 692t. Five vessels fished along the New Brunswick coast for a few nights and landed 726t.

October 22 – October 28 (Fig. 6: Week 43)
Nine vessels fished from Grand Manan, landing 638t. One vessel fished along the Long Island Shore, landing 7t. This ended the fishery along Long Island Shore until spring. Ten vessels fished along coastal New Brunswick for one night this week, landing 806t.

October 29 – November 4 (Fig. 6: Week 44)
The same nine vessels remained off Grand Manan this week, landing 403t. Two vessels remained fished along the coast of New Brunswick for one night and landed 164 tons of fish.

November 5 – November 11 (Fig. 6: Week 45)
Two boats fished off Grand Manan, landing 129t. This ended the Grand Manan fishery until spring. One vessel fished along the coast of New Brunswick for one night and landed 5t. This ended the fishery here for the season.

Coastal Nova Scotia

Summary

- 1999 gillnet fishery (focused on Little Hope and Eastern Passage)
- 1999 total landing (7,351t) were higher then 1998 (4,192t) but half that of 1997 (2,965t)
- The gillnet fishery was similar in location and timing to previous years

Eastern Passage

The Eastern Passage roe fishery started on September 27th and finished October 22nd (Fig. 7: Week 39-41; Fig. 8: Week 42-43). At the start of the season there were approximately 20 boats fishing off Three Fathom Harbour and all boats caught their trip

limit. During the first week of the fishery the market was saturated, making it hard to sell fish. Fishing during morning slack tides seemed to produce the best catches. At the beginning of October PRC staff, with the help of Kelly Fitzgerald, a seiner captain from Aspey Bay Cape Breton, tagged 1896 herring over four nights. A sample was taken during this survey and the fish size ranged in length from 24.5 – 37.5cm with a mode at 30.5cm. The following night, 11 gillnetters conducted their own mapping survey of the area, documenting 20,226t of fish. During the day on October 4th an acoustic survey was conducted using the research vessel the J.L. Hart. This survey documented 4,658t of fish. On October 10th, another industry survey was conducted on Eastern Passage. Four gillnet boats conducted a mapping survey off Eastern Passage and four conducted a mapping and acoustic survey off Jeddore. A total of 9,500t was documented. A total of 1,620t of herring were landed from the fall drift net fishery. There was also a small set net fishery in this area, starting the first of May and continuing through until the second week of June (Fig. 7: Week 18-23). A total of 8 tons was landed from this fishery.

Little Hope

The Little Hope fishery started the third week of September and ended the third week of October (Fig. 7: Week 37-41; Fig. 8: Week 42). Around 20 drift netters and 17 set netters fished the Little Hope area during this time period. A mapping survey involving 20 boats was conducted for Little Hope on September 26th. A total of 6,150t was documented. Another survey was conducted on October 3rd using the portable acoustic gear mounted on the research vessel the J.L. Hart. This survey documented 14,600t. A total of 2,919t was landed from this area.

Overwintering Areas

Summary

- Chedabucto Bay fishery from November 14th to November 30th (1998 &1999)
- The fishery was similar in location and time to previous years.
- Landings for Chedabucto Bay were similar for 1998 (1,582t) and 1999 (1,235t)
- Chebucto Head observations from January 8th to 23rd (2000)
- Small overwintering aggregation in Chedabucto Bay, but large aggregation at Chebucto Head as in recent years.

1998

Chedabucto Bay

Two seiners fished on the Grime Shoal area, Chedabucto Bay from November 14th to November 30th (Fig. 5: Week 46-48). Herring were caught between 1 and 6pm. Towards the end of the fishery, fish were caught from 3 to 5:30pm. Captains reported

that the fish were bunched up in the middle of the afternoon and then after 5:00pm they moved to the bottom and disappeared from view. Good landings were reported on Nov. 14, 17, 18, 19, 22, 26, and 30th. Bad weather affected the fishing effort. Fish ranged in length from 20.0 - 32.5cm. The boats left Chedabucto Bay at the beginning of December. It was noted that many tuna were seen in the area. The total landings from Chedabucto Bay for 1998 were 1,582t.

1999

Chedabucto Bay

Three seiners fished in the Chedabucto Bay area from November 14th to 30th (Fig. 6: Week 46-48). Fish were caught between 4pm and early morning. The fishery was hampered by poor weather. Captains reported that the fish would move to shoal water at dark. This made the fish difficult to catch when the wind was high. A total of 3,505t of herring were tagged by PRC staff between November 26th and 30th. Fish landed from this area had a wide length range (20.0 – 37.0cm)with two modes, one dominant mode occurring at 26.5cm and one lesser mode occurring at 29.5cm. A total of 1,235t of herring were landed from Chedabucto Bay this season.

2000

Chebucto Head

Herring schools were observed off Chebucto Head from January 8th to 23rd (Fig. 6: Week 2-4). Acoustic surveys and tagging involving 3 vessels, occurred on the 8th, 9th and 10th. Participating seiners were permitted to take 100t of herring as compensation for each night of tagging or surveying, up to a maximum of 1,000t. An additional acoustic survey was conducted on January 13th by vessels with acoustic gear. Herring ranged in size from 18.5 to 33.5cm with a mode of 25cm.

Table 1: Summary of mapping and acoustic information collected during the 1999 fishery.

Area	Date	# of vessels Involved	# of Mapping Records	# of Acoustic Records
Scot's Bay	25-Jul-99	1	0	1
	30-Jul-99	1	0	1
	2-Aug-99	1	0	1
	8-Aug-99	1	0	1
	9-Aug-99	1	0	1
	10- Aug-99	3	3	1
	20-Aug-99	6	4	2
	3-Sep-99	3	3	2
Spec Buoy	28-Jun-99	Cancelled		
	05-Jul-99	Cancelled		
Trinity Ledge	27-Aug-99	2	0	2
	1-Sep-99	Cancelled		
	9-Sep-99	8	7	1
	13-Sep-99	Cancelled		
	24-Sep-99	Cancelled		
German Bank	27-Aug-99	5	5	2
	10-Sep-99	6	6	1
	25-Sep-99	5	5	1
	02-Oct-99	1	0	1
	8-Oct-99	1	1	0
Chebucto Head	7-Jan-00	3	0	2
	8-Jan-00	2	0	2
	9-Jan-00	2	0	2
	10-Jan-00	2	0	2
	15-Jan-00	2	1	1
	22-Jan-00	1	0	1
	23-Jan-00	1	0	1
Offshore				
The Patch	10-Jun-00	7	6	3
Georges Bank	25-Oct-99 to 2-Nov-99	1	0	5
Scotian Shelf	3-Nov-99 to 12-Nov-9	1	0	13
Little Hope	23-Sep-99	Cancelled		
	26-Sep-99	20	19	0
	03-Oct-99	1	1	1
	14-Oct-99	Cancelled		
Eastern Passage	1-Oct-99	1	1	0
	2-Oct-99	11	11	0
	4-Oct-99	1	1	1
	10-Oct-99	7	6	1
	22-Oct-99	Cancelled		

Table 1: continued.

Area	Date	# of vessels involved	# of Mapping Records	# of Acoustic Records
Bras d'Or Lakes	20-Feb-99	1	1	0
	8-Apr-99	1	1	0
	9-Apr-99	1	1	0
	14-Apr-99	1	1	1
	15-Apr-99	1	1	1
Glace Bay	21-Sep-99	1	1	0
	12-Oct-99	Cancelled		

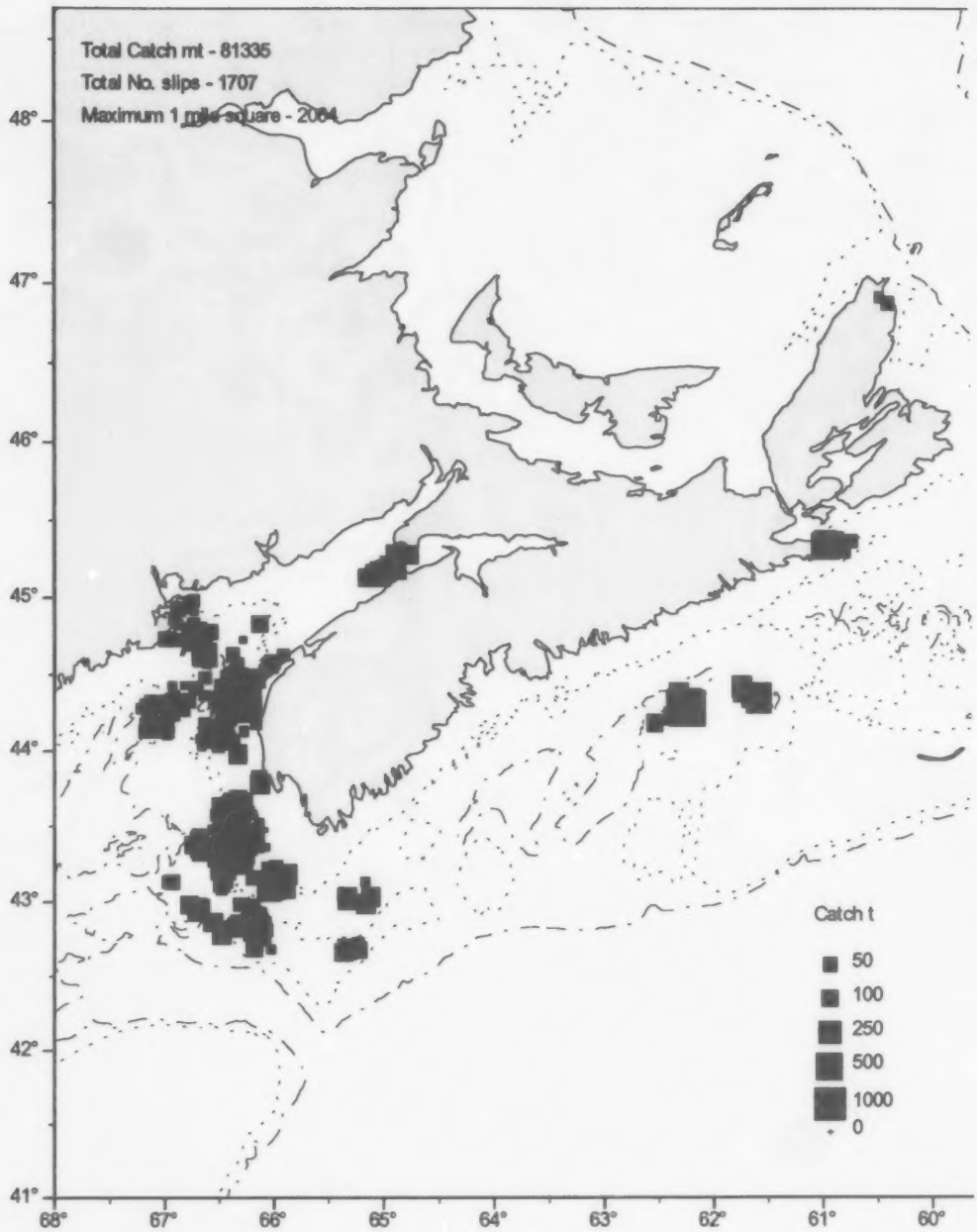


Figure 1. 4VWX herring purse seine catches for quota year 1998-99 from Oct. 15, 1998 to Oct. 14, 1999. (data summed by 1 mile squares).

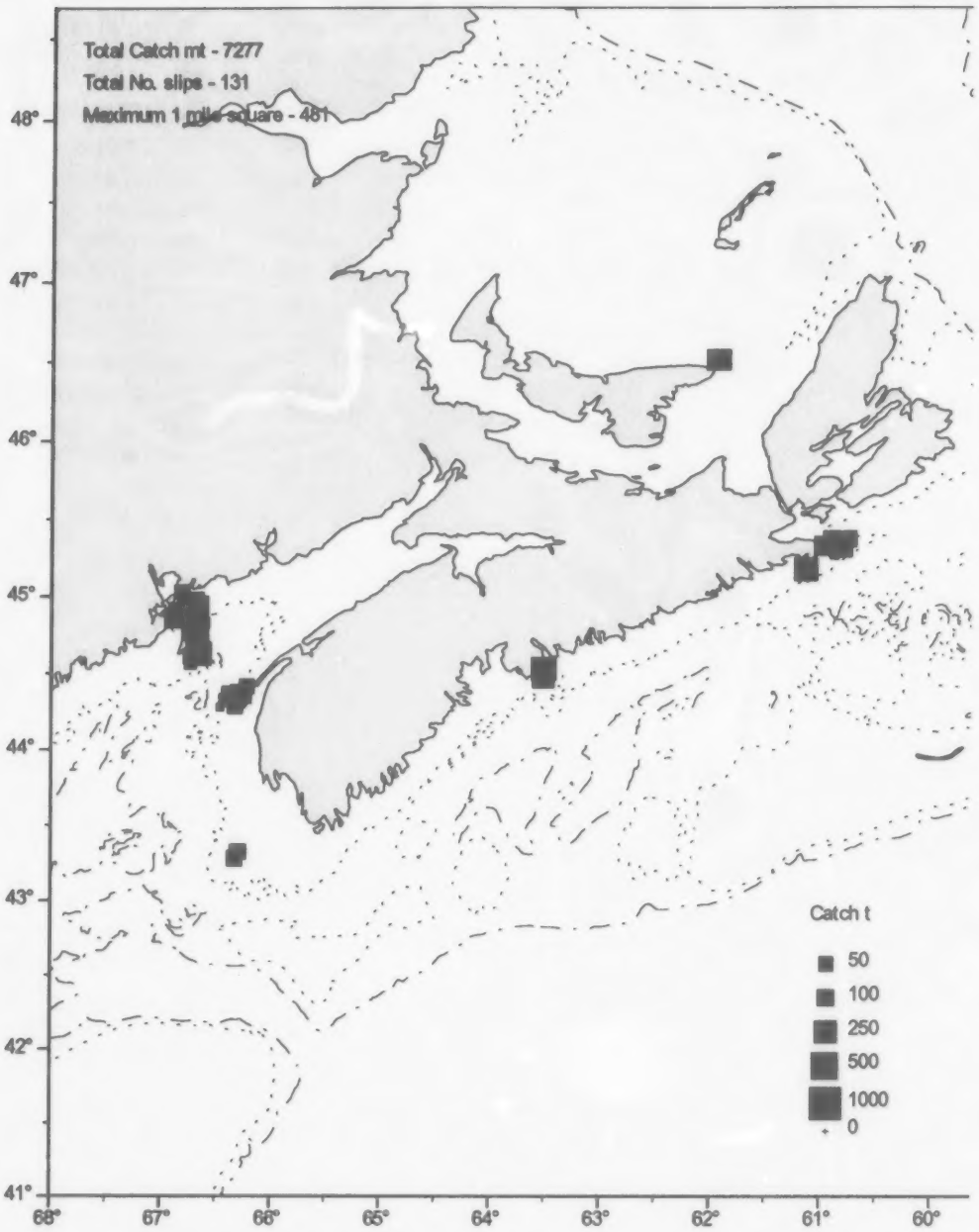


Figure 2. 4VWX herring purse seine catches for quota year 1999-2000 from Oct. 15,1999 to March 1, 2000. (data summed by 1 mile squares).

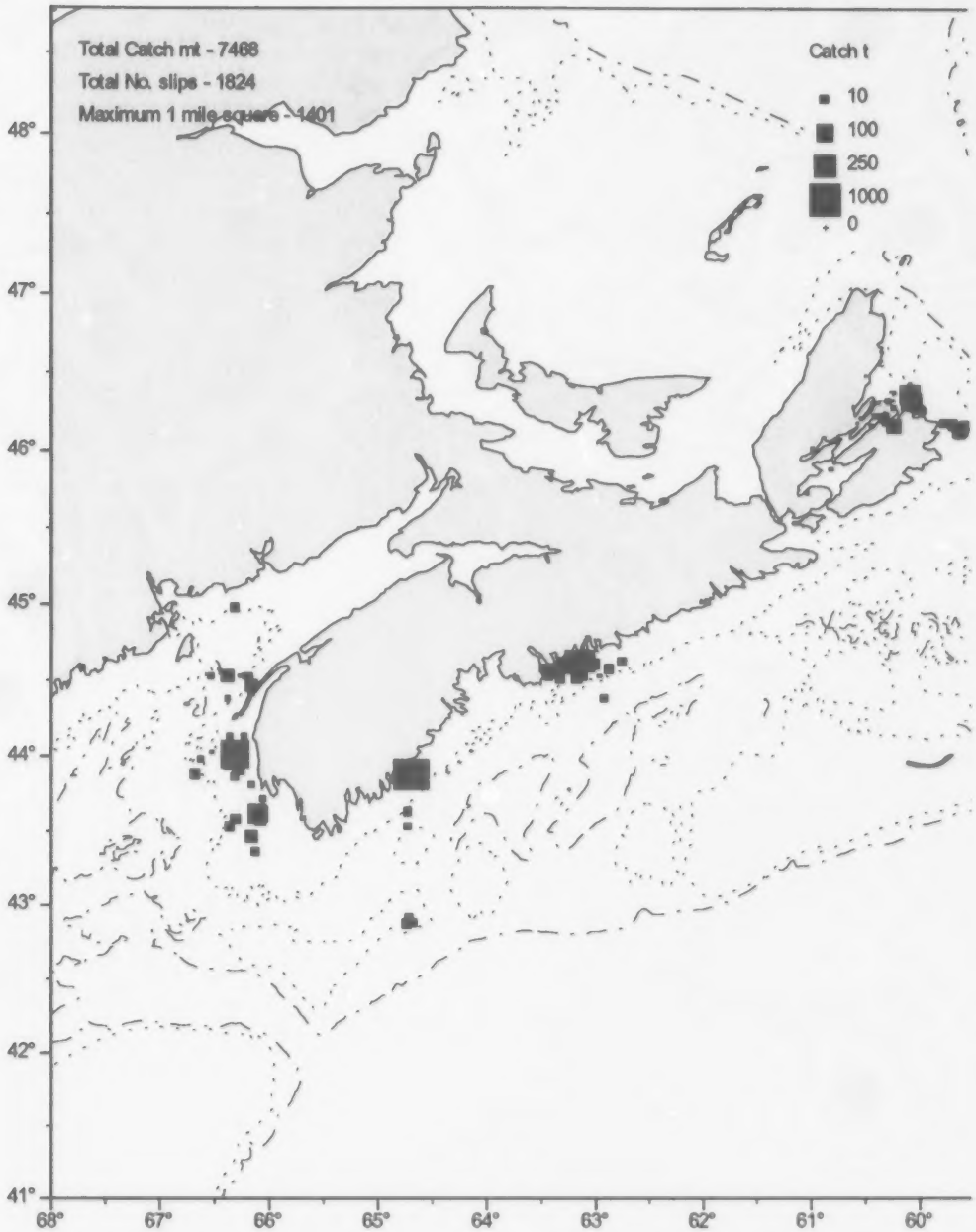


Figure 3. 4VWX herring gillnet catches for quota year 1998-99 from Oct. 15, 1998 to Oct. 14, 1999. (data summed by 1 mile squares).

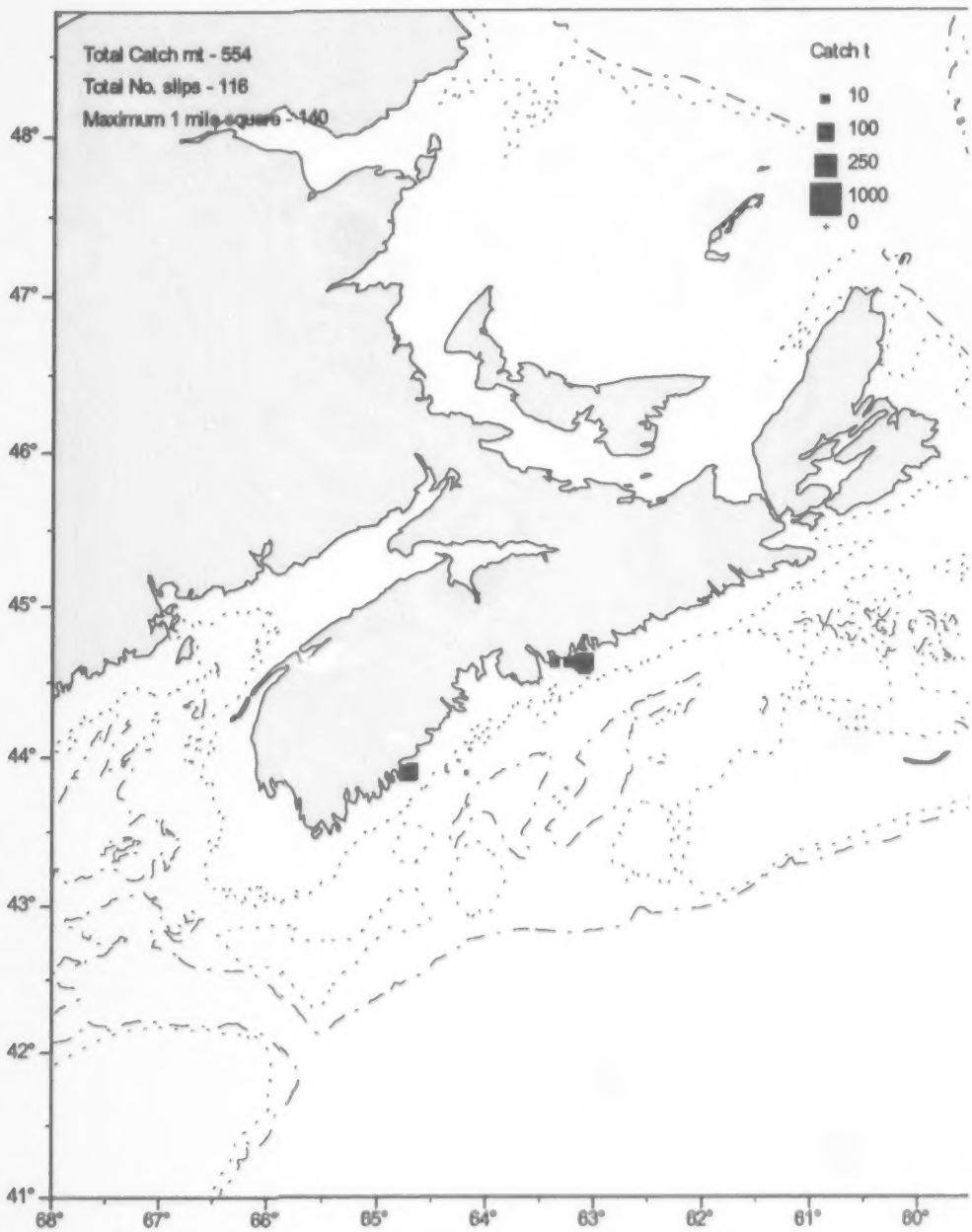


Figure 4. 4VWX herring gillnet catches for quota year 1999-2000 from Oct. 15,1999 to March 1, 2000. (data summed by 1 mile squares).

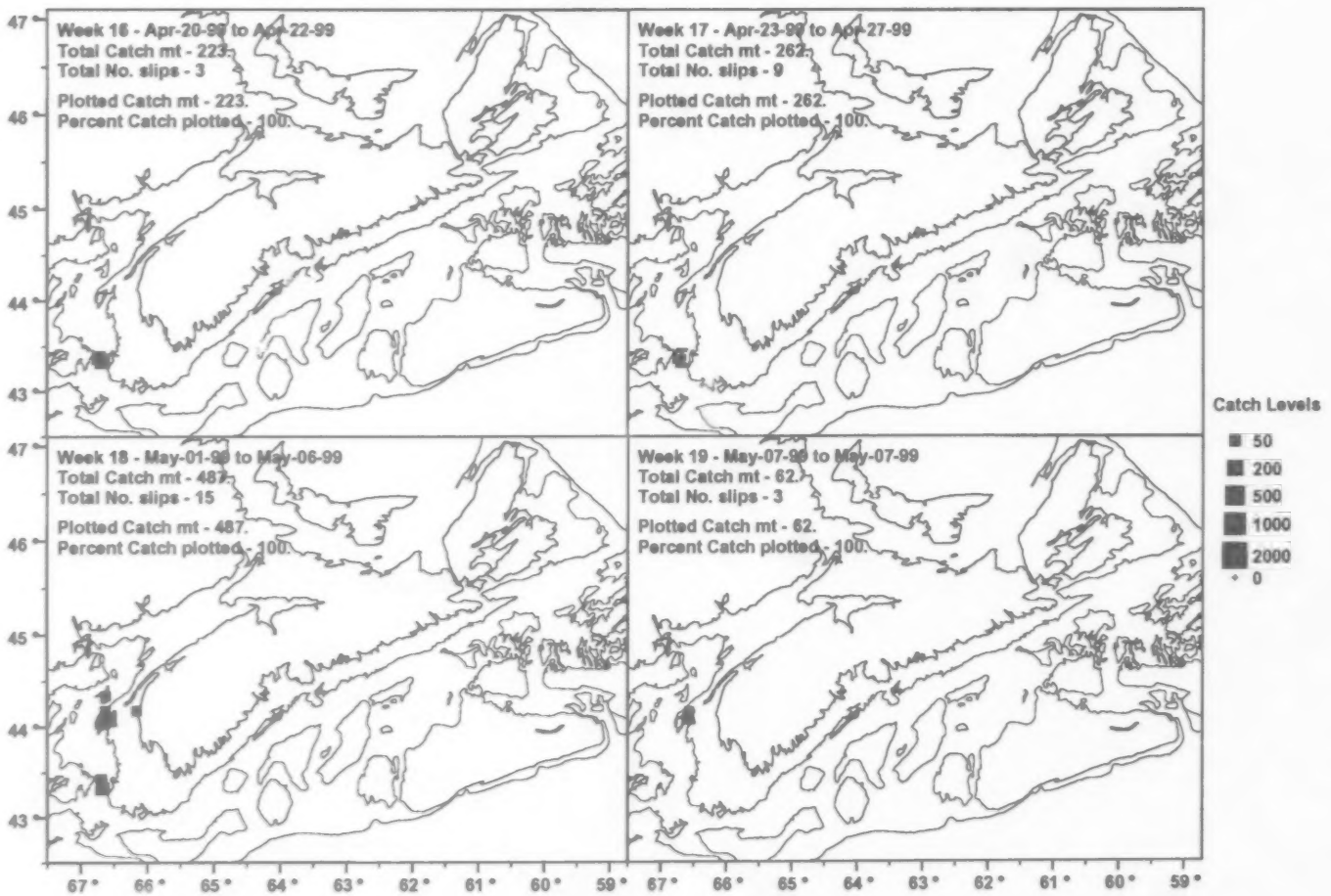
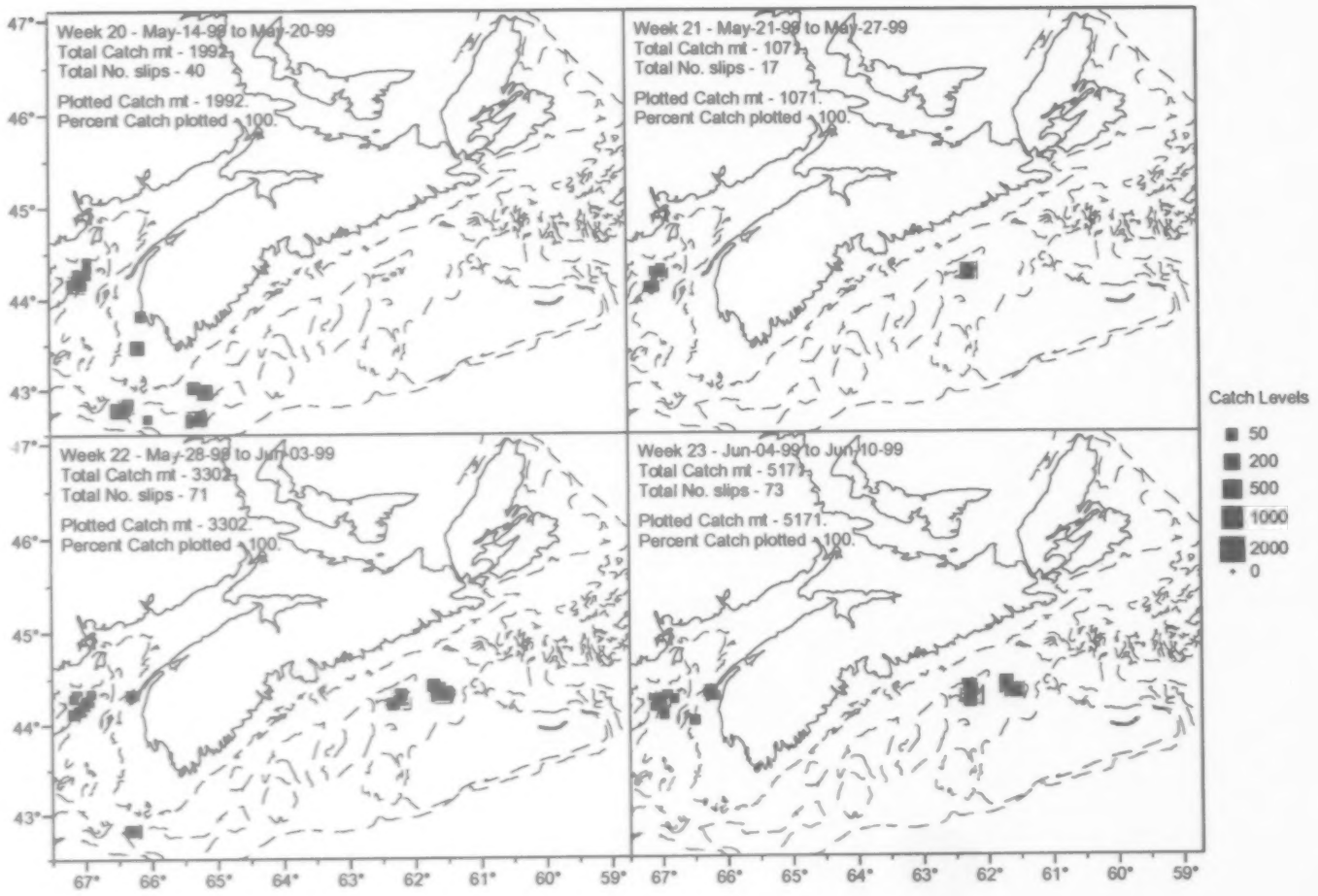


Figure 5. 4VWX herring purse seine catches by week for quota year Oct. 15, 1998 to Oct. 14, (by 1 mi. boxes).



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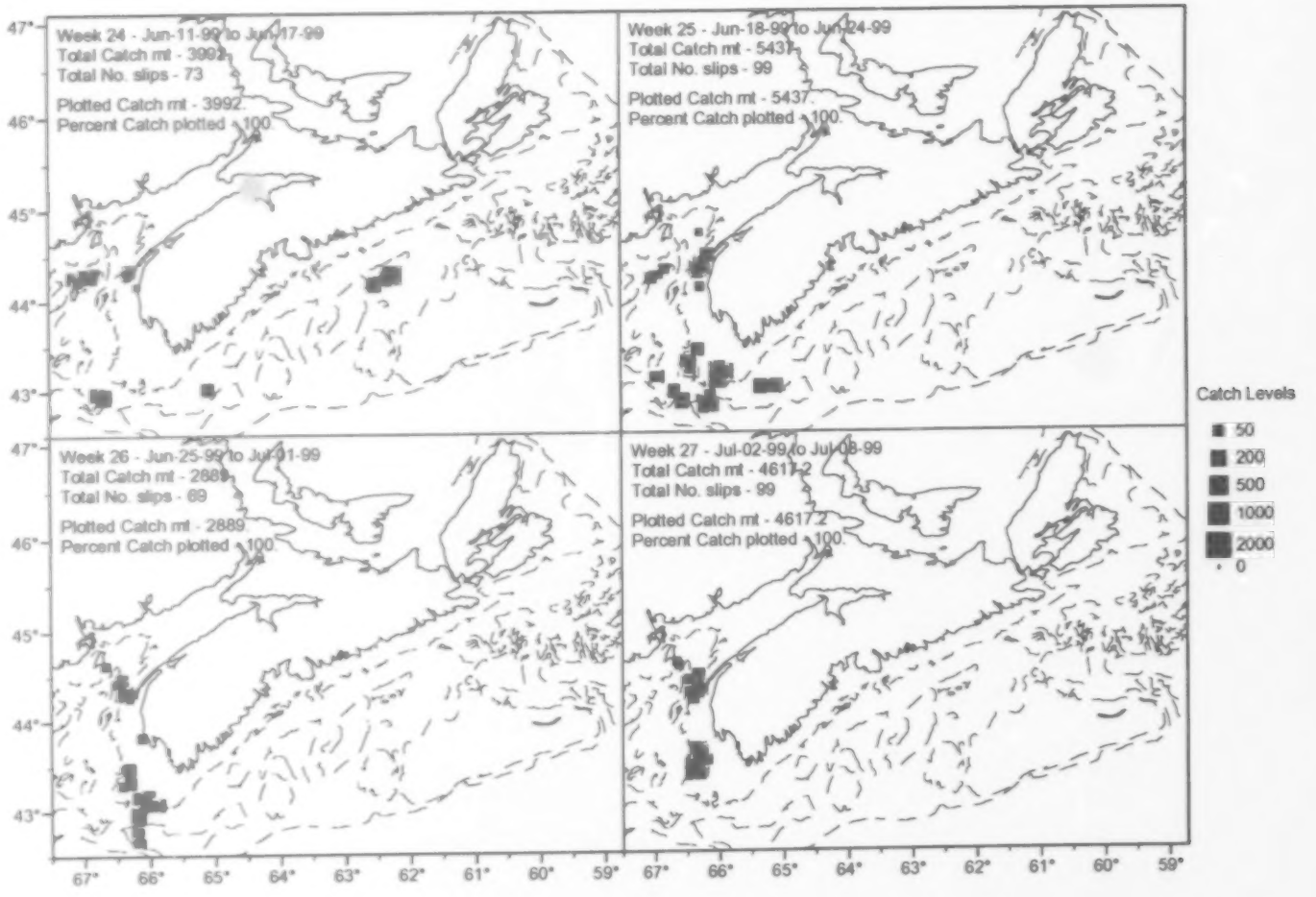

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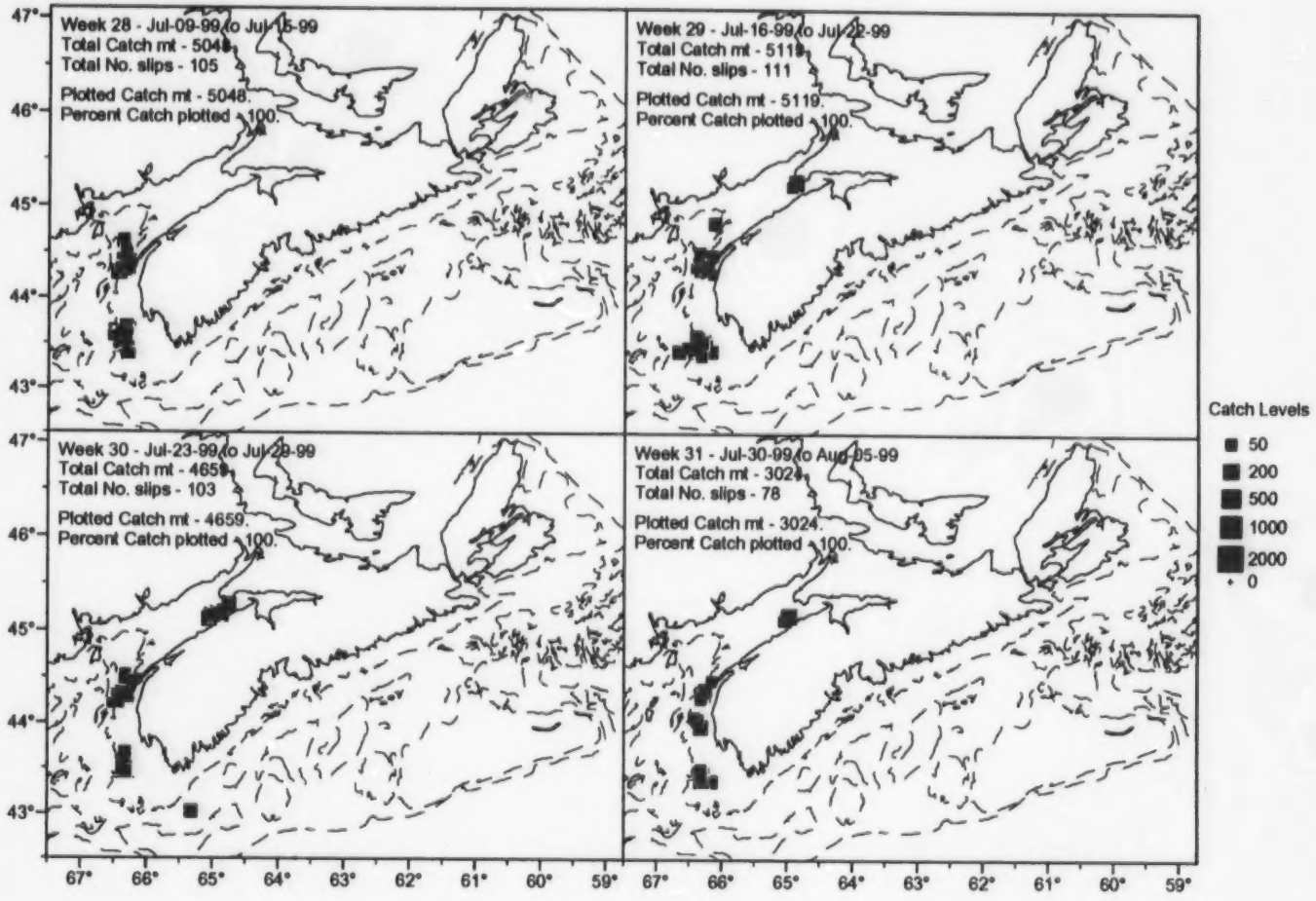

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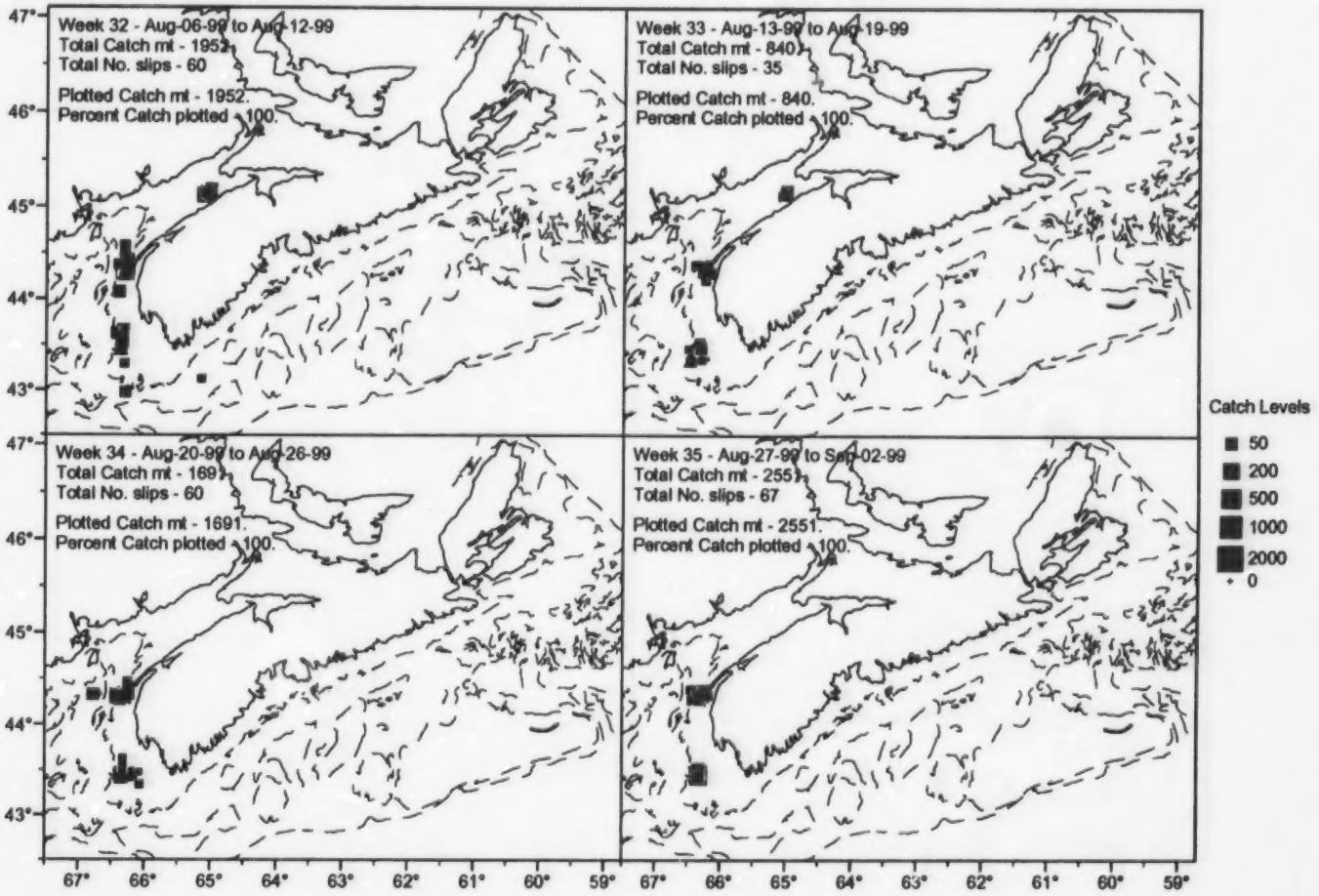

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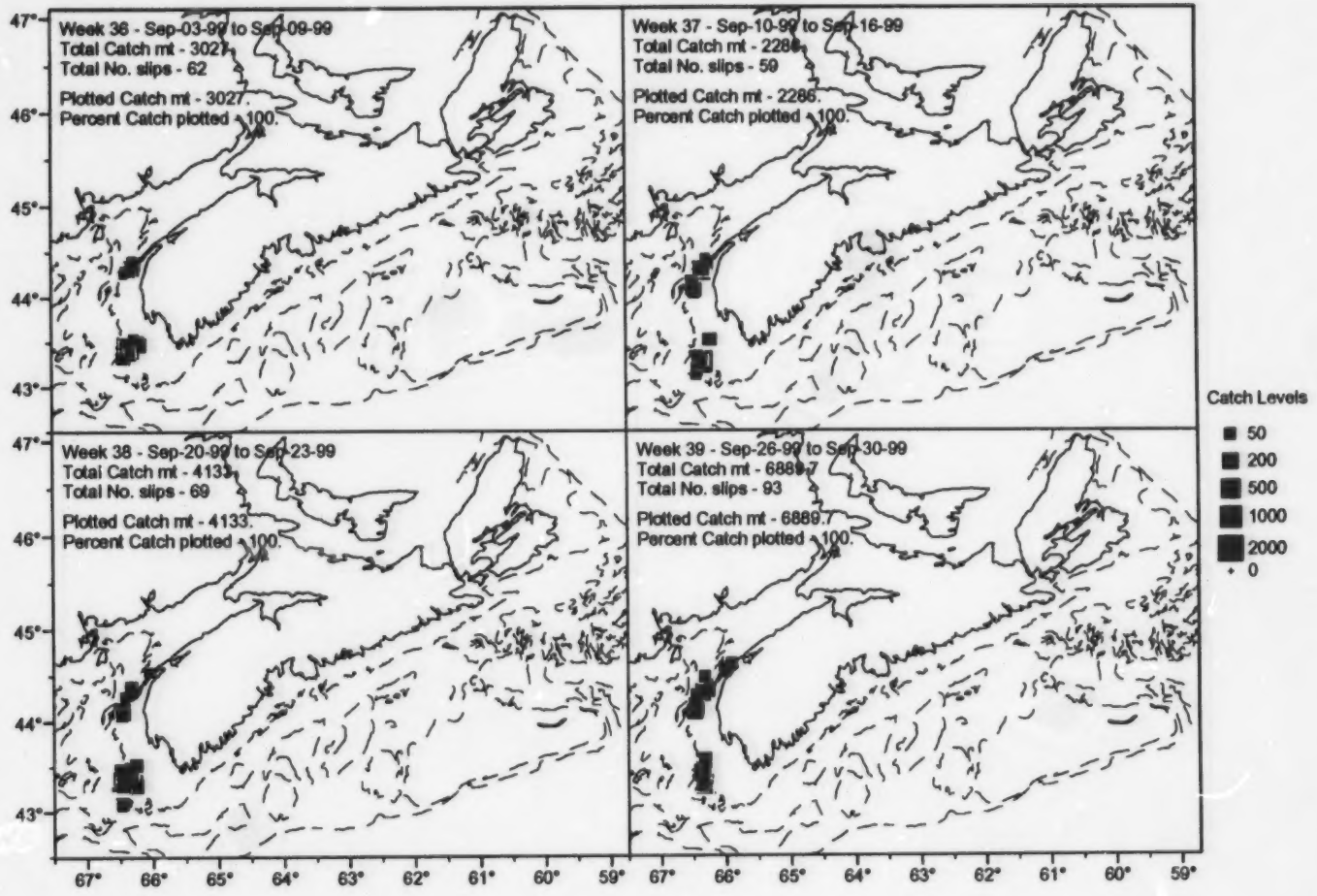

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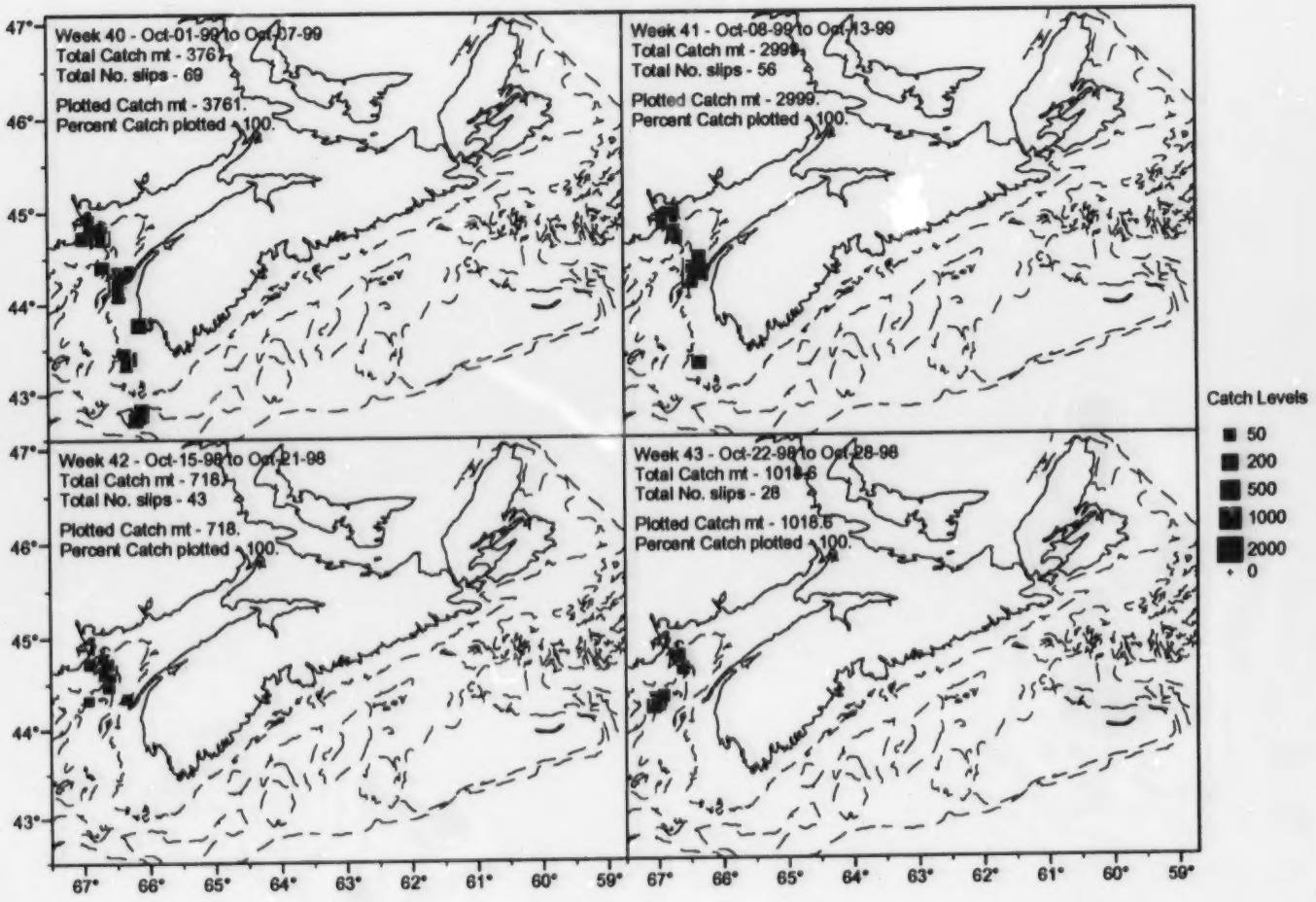

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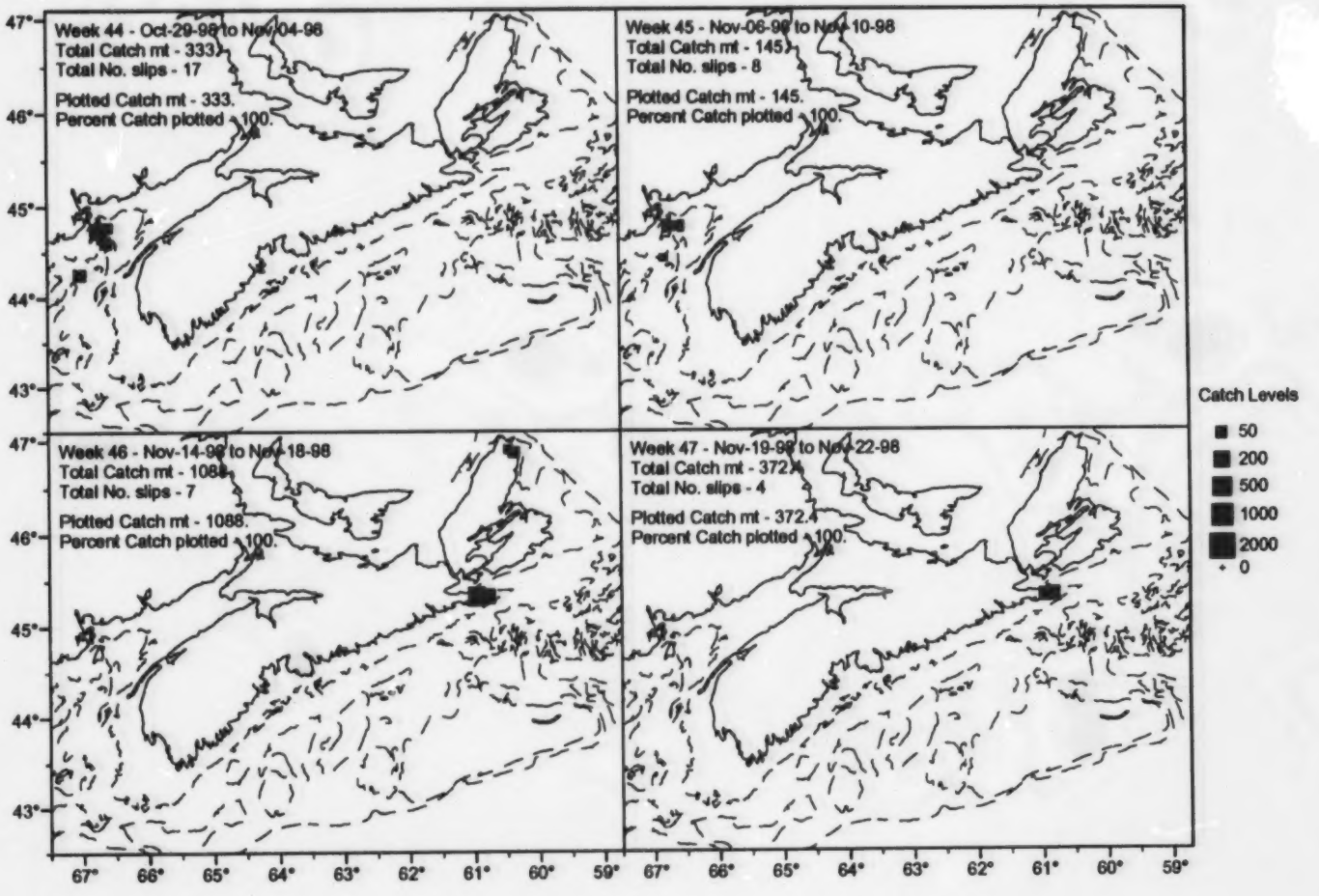

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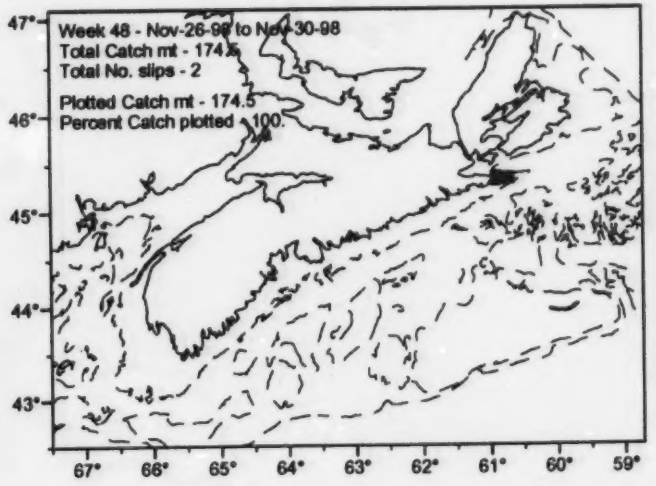

Catch Levels

- 50
- 200
- 500
- 1000
- 2000
- 0

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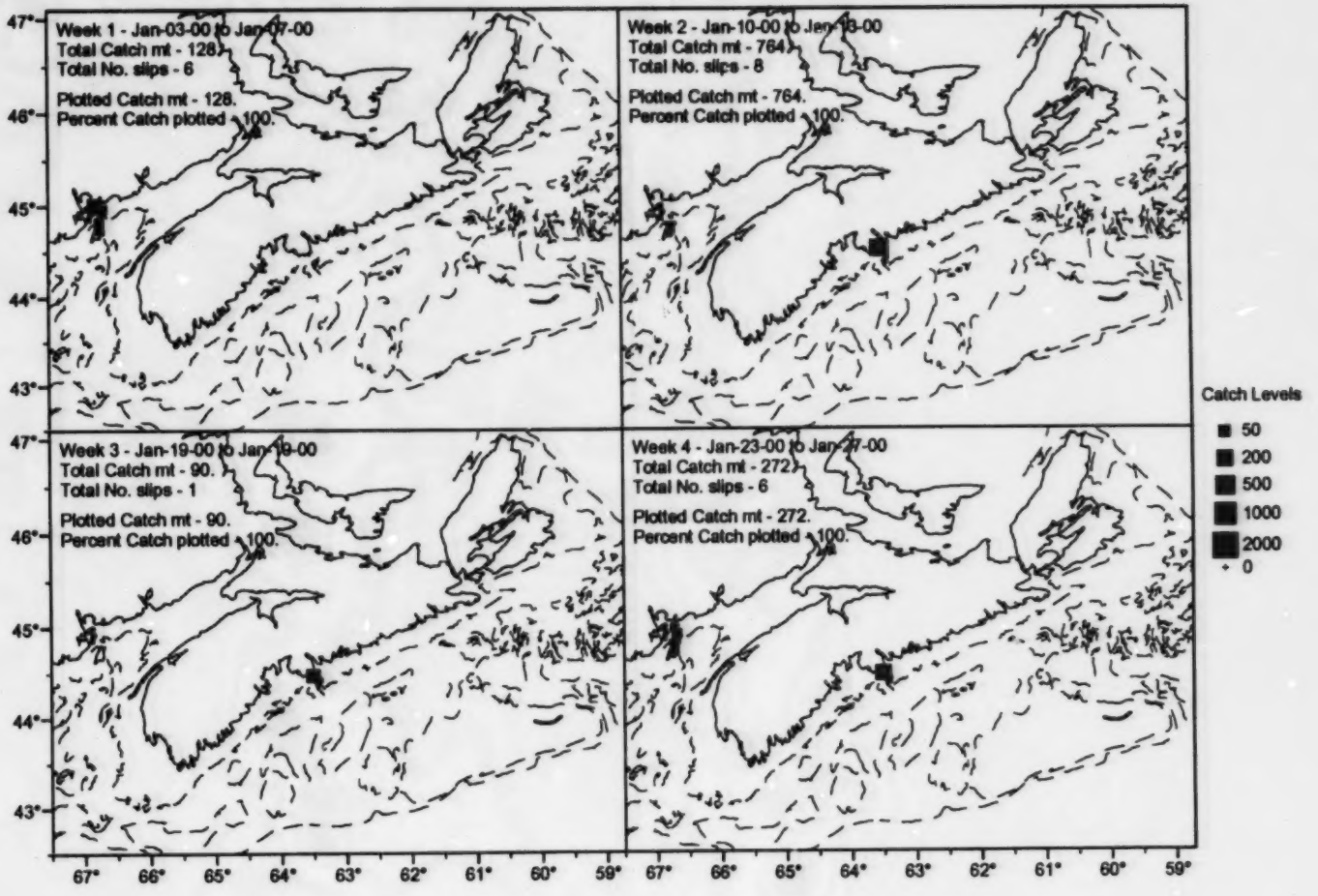
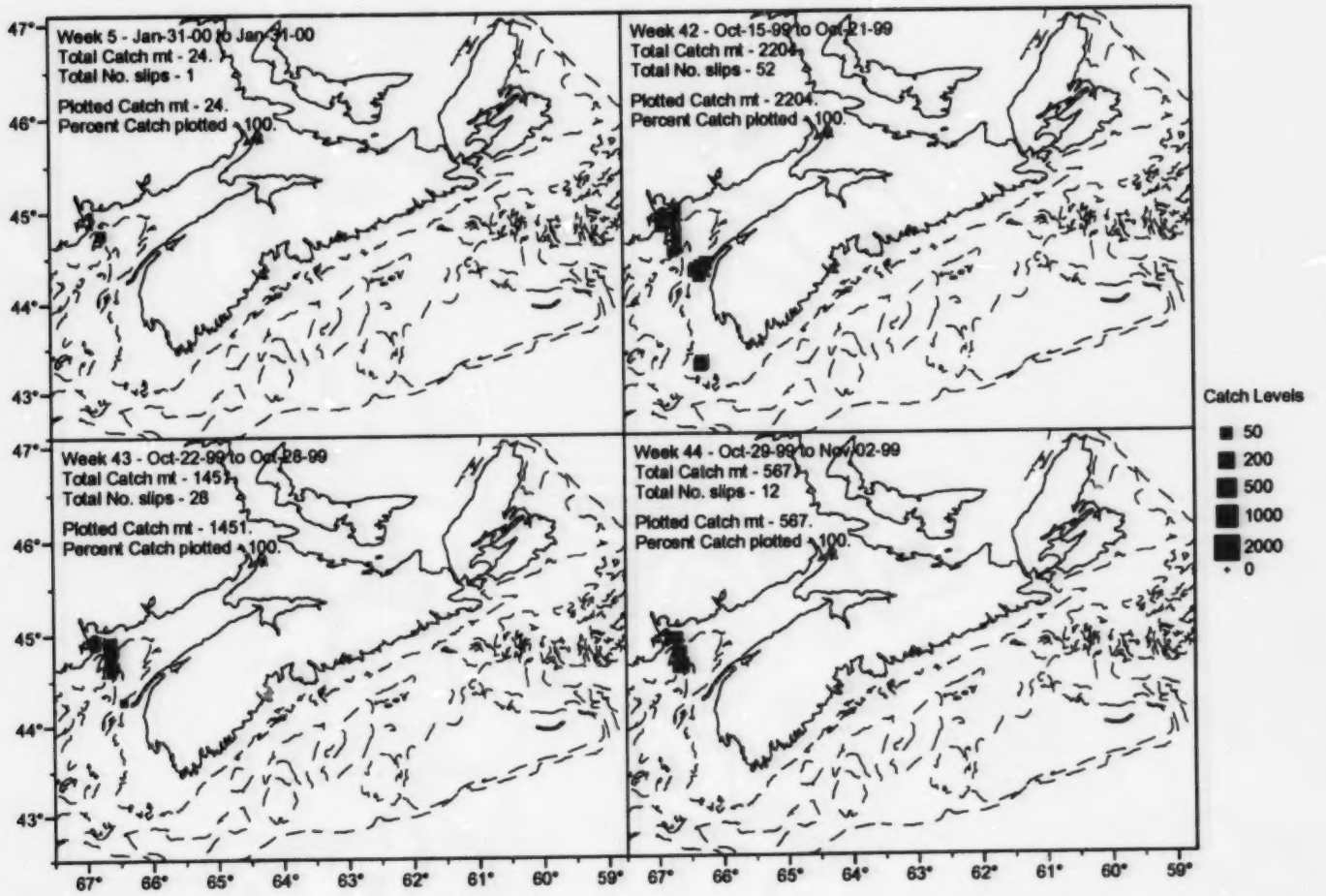


Figure 6. 4VWX herring purse seine catches by week for quota year Oct. 15, 1999 to Mar. 1, 2000. (by 1 mi. boxes).



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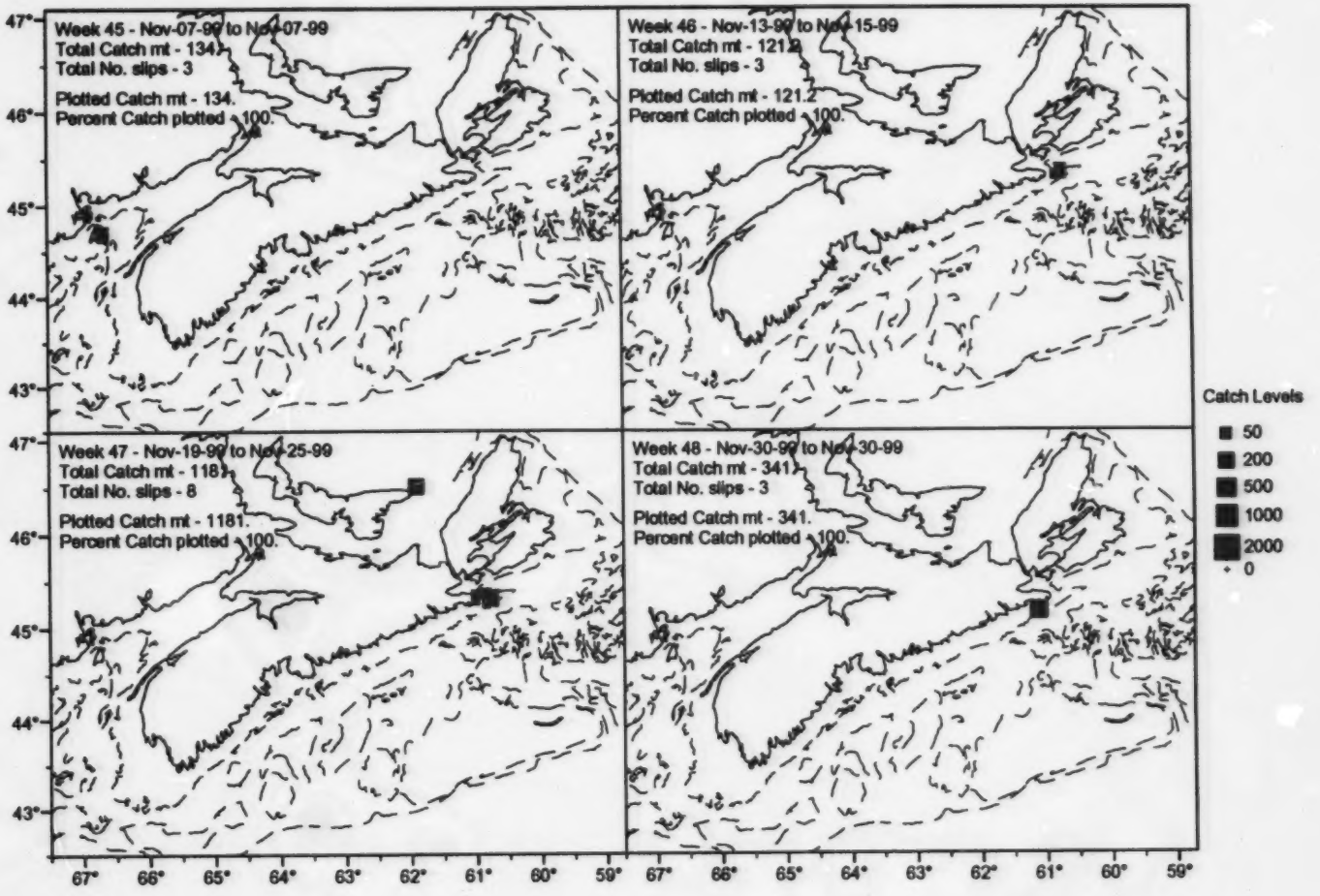

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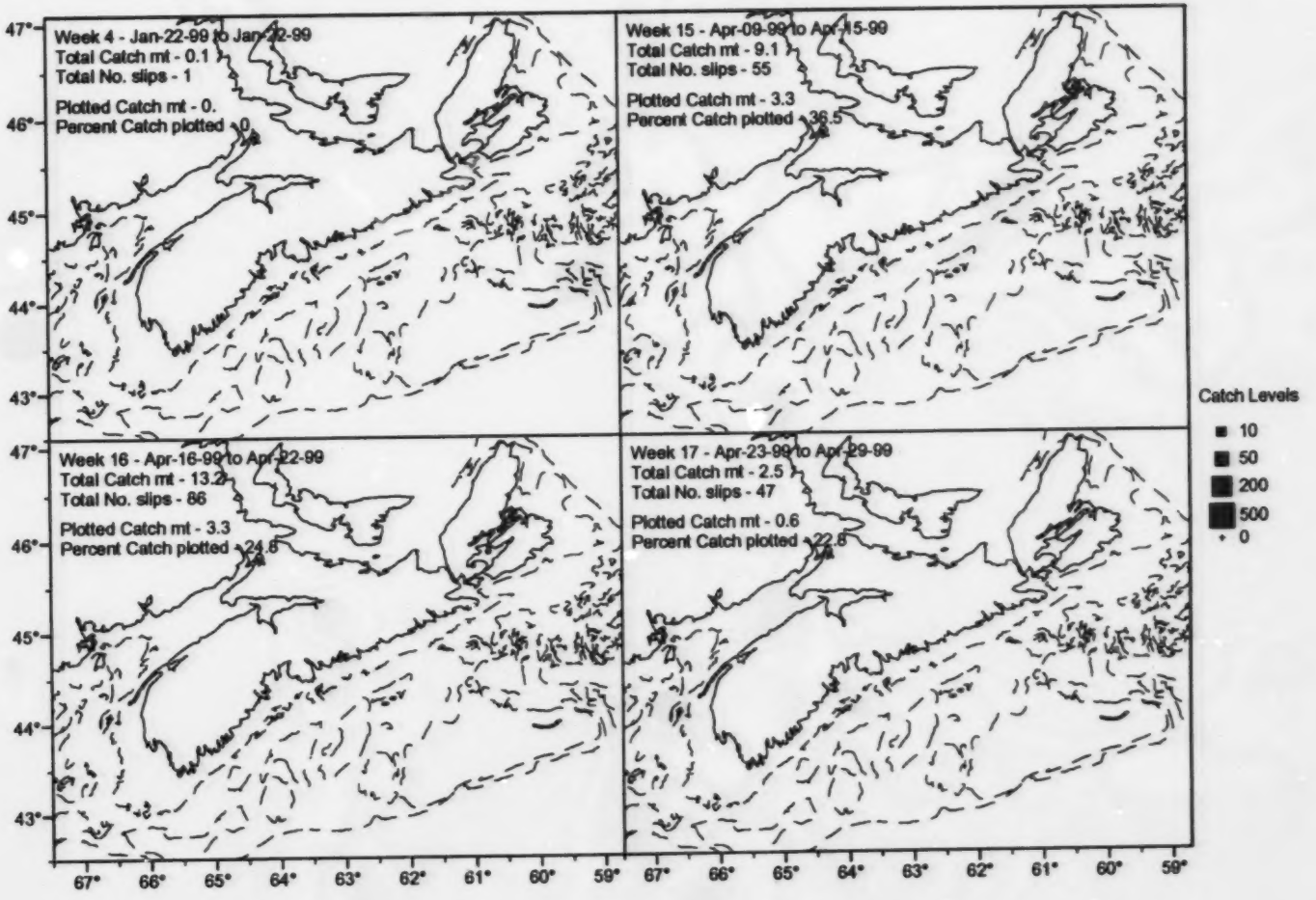
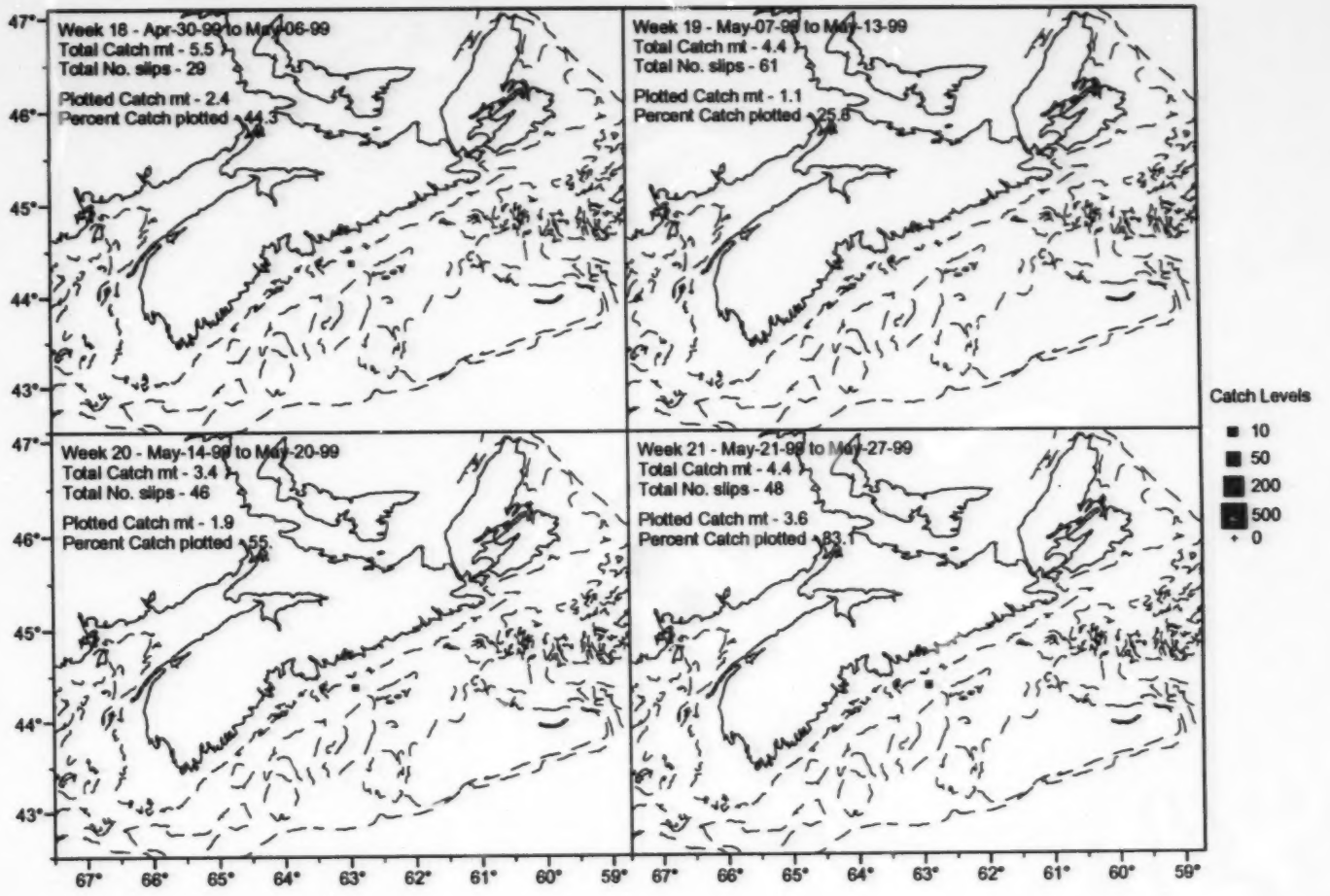


Figure 7. 4VWX herring gillnet catches by week for quota year Oct. 15, 1998 to Oct. 14, 1999. (by 1 mi. boxes).



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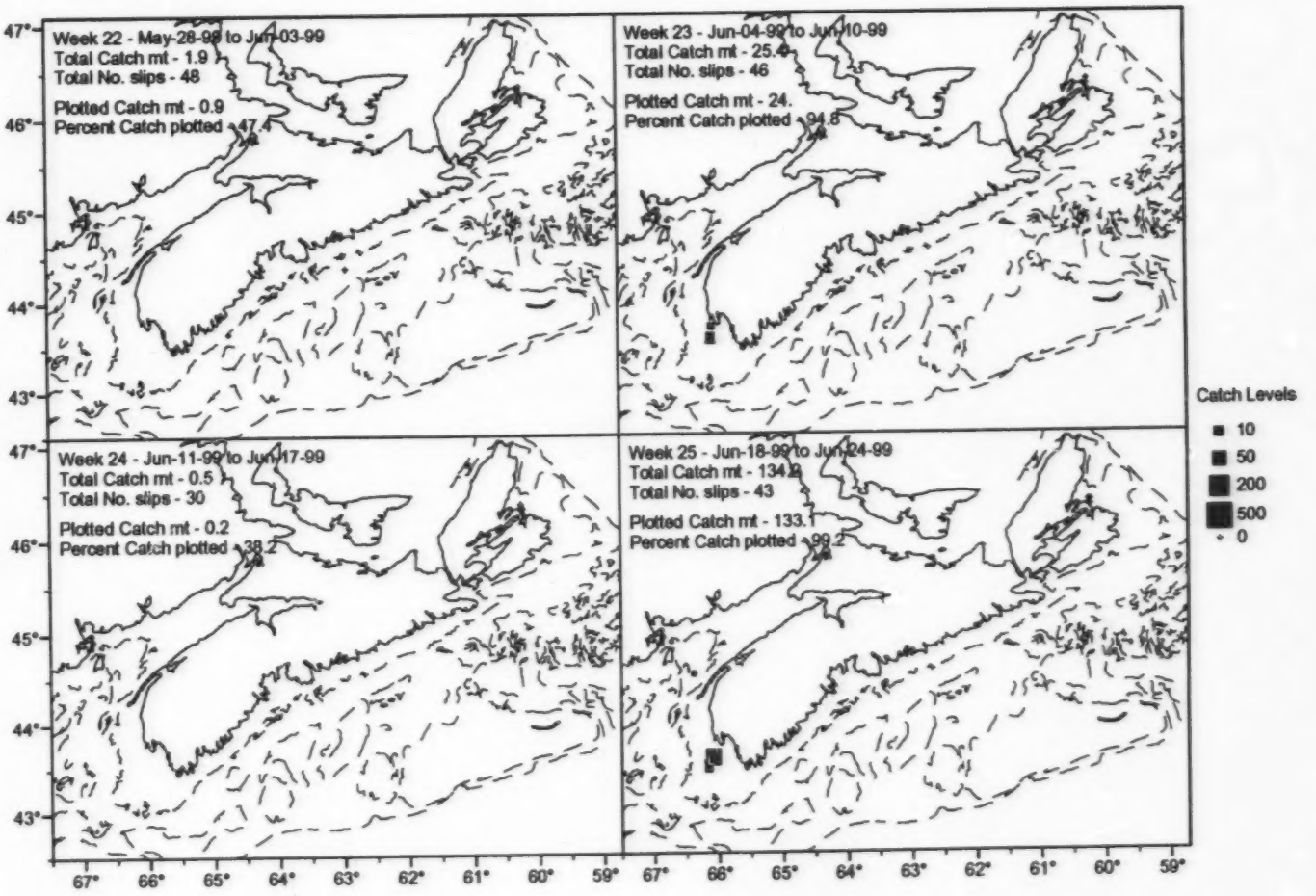

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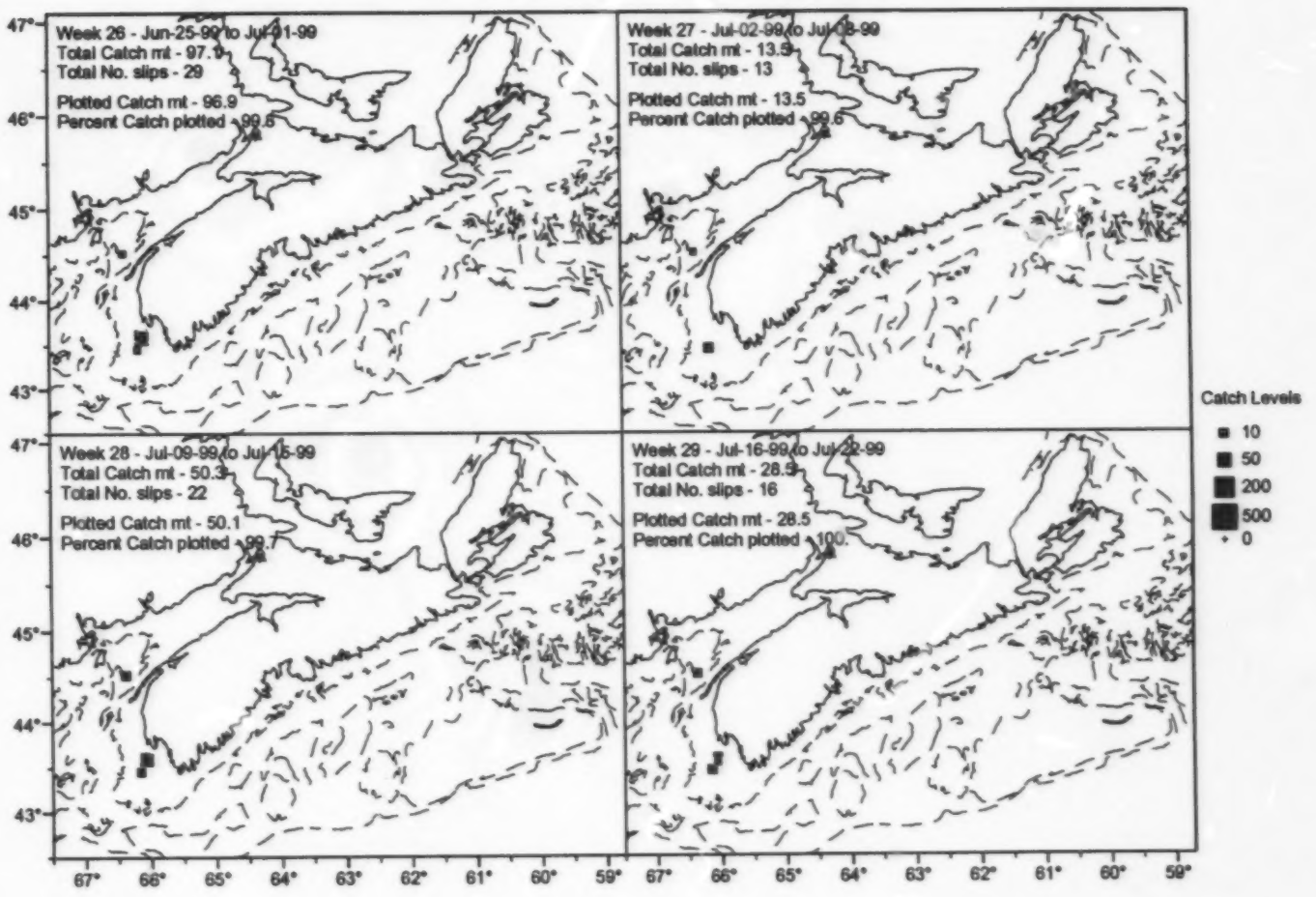

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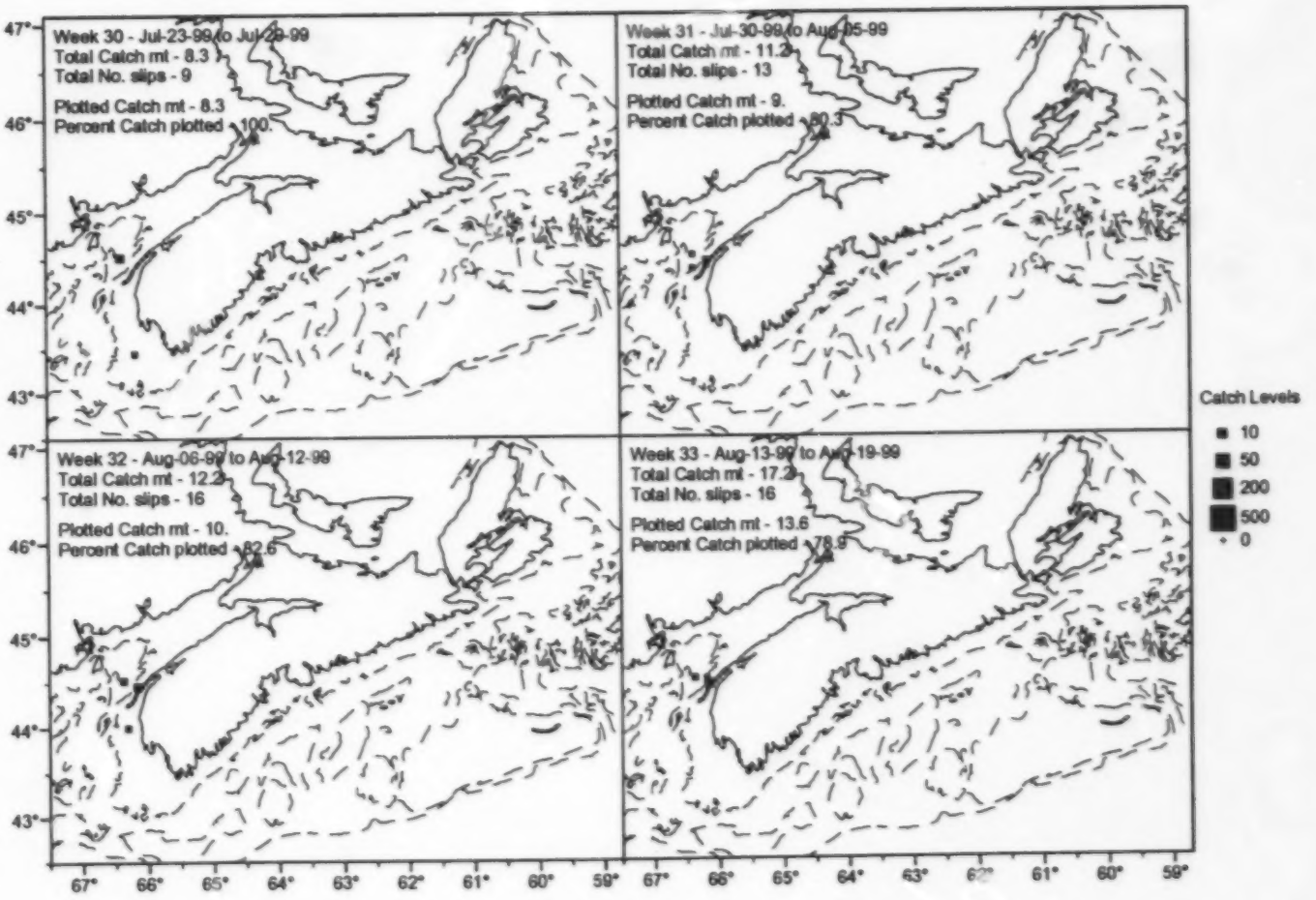

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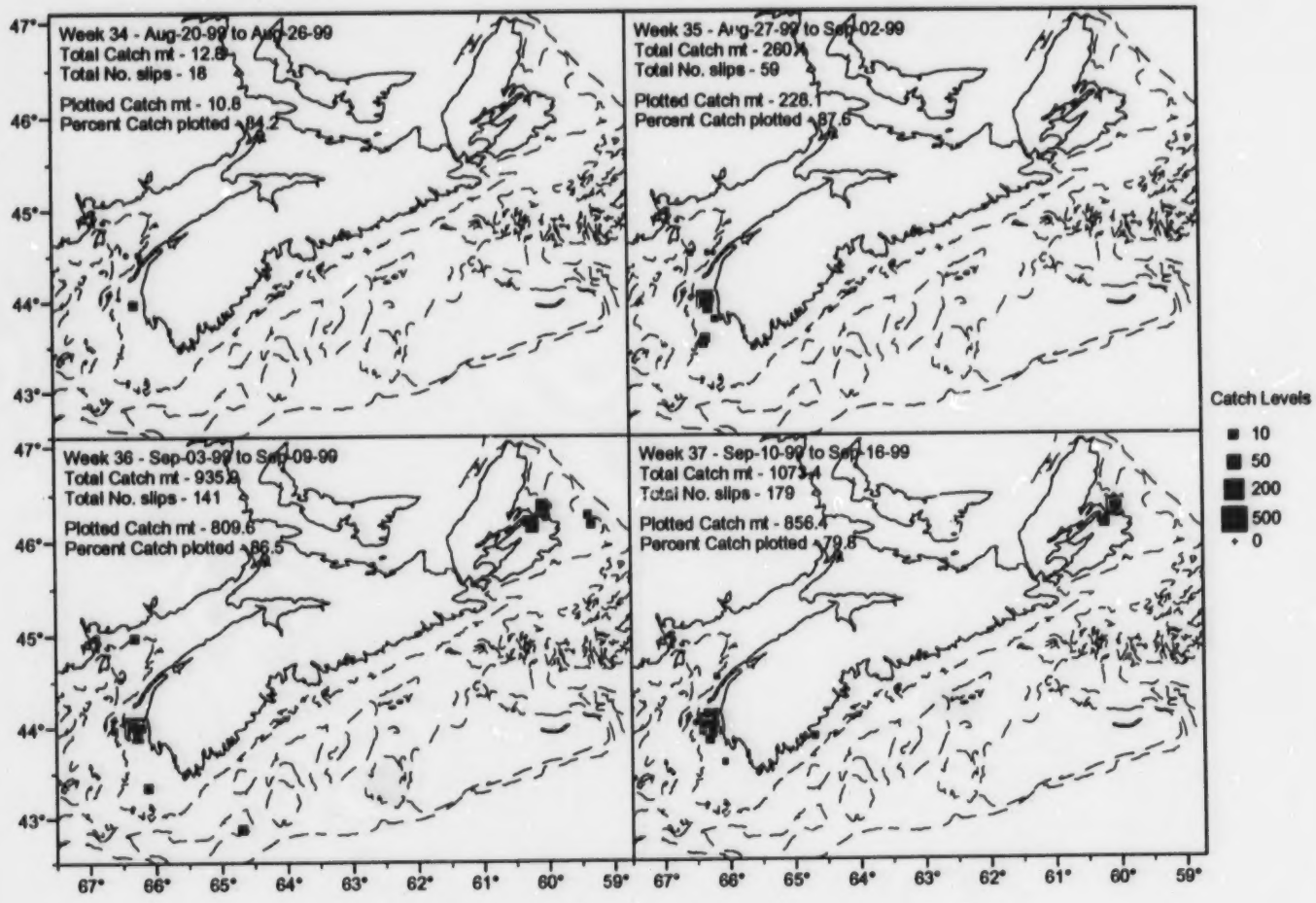

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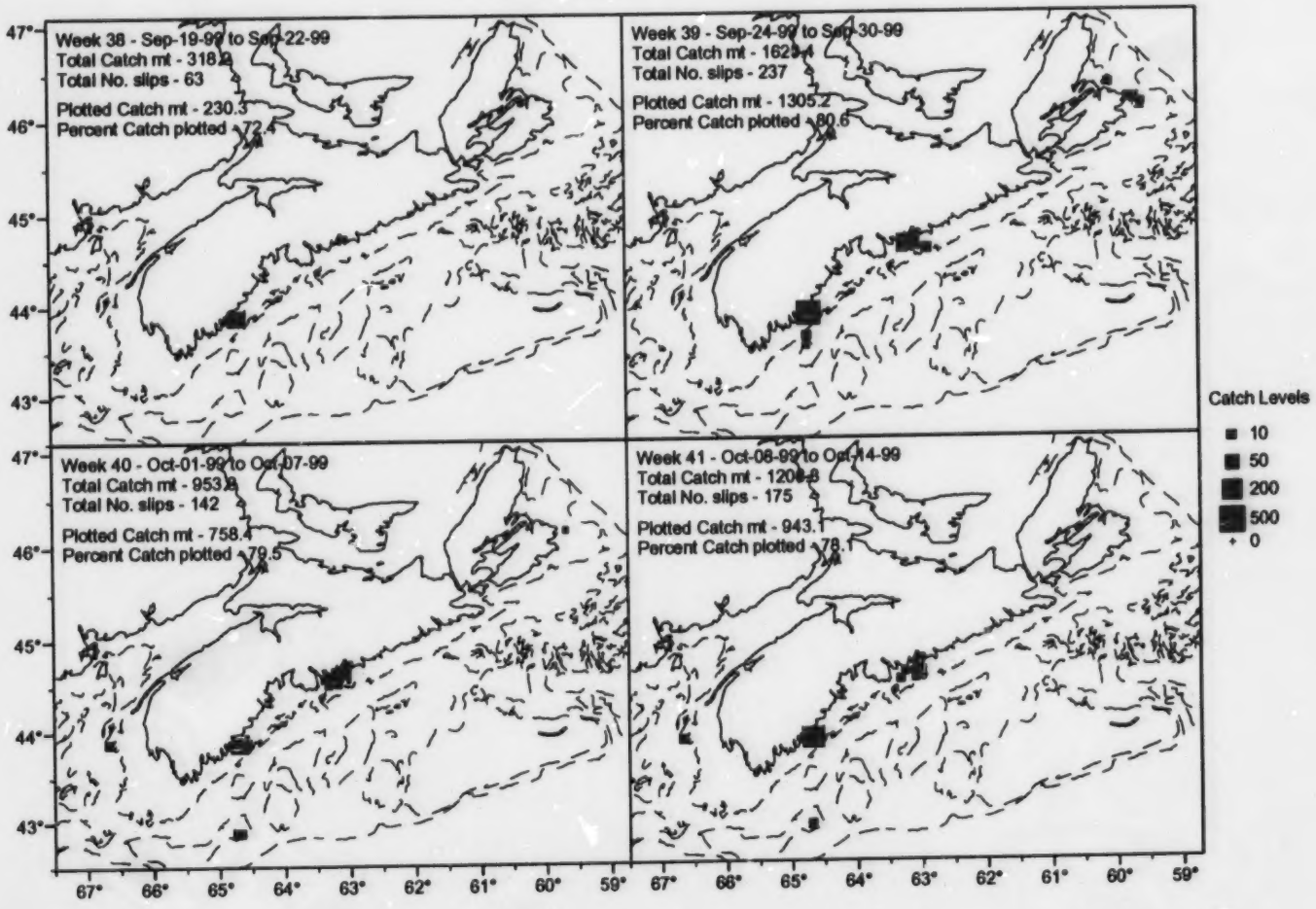

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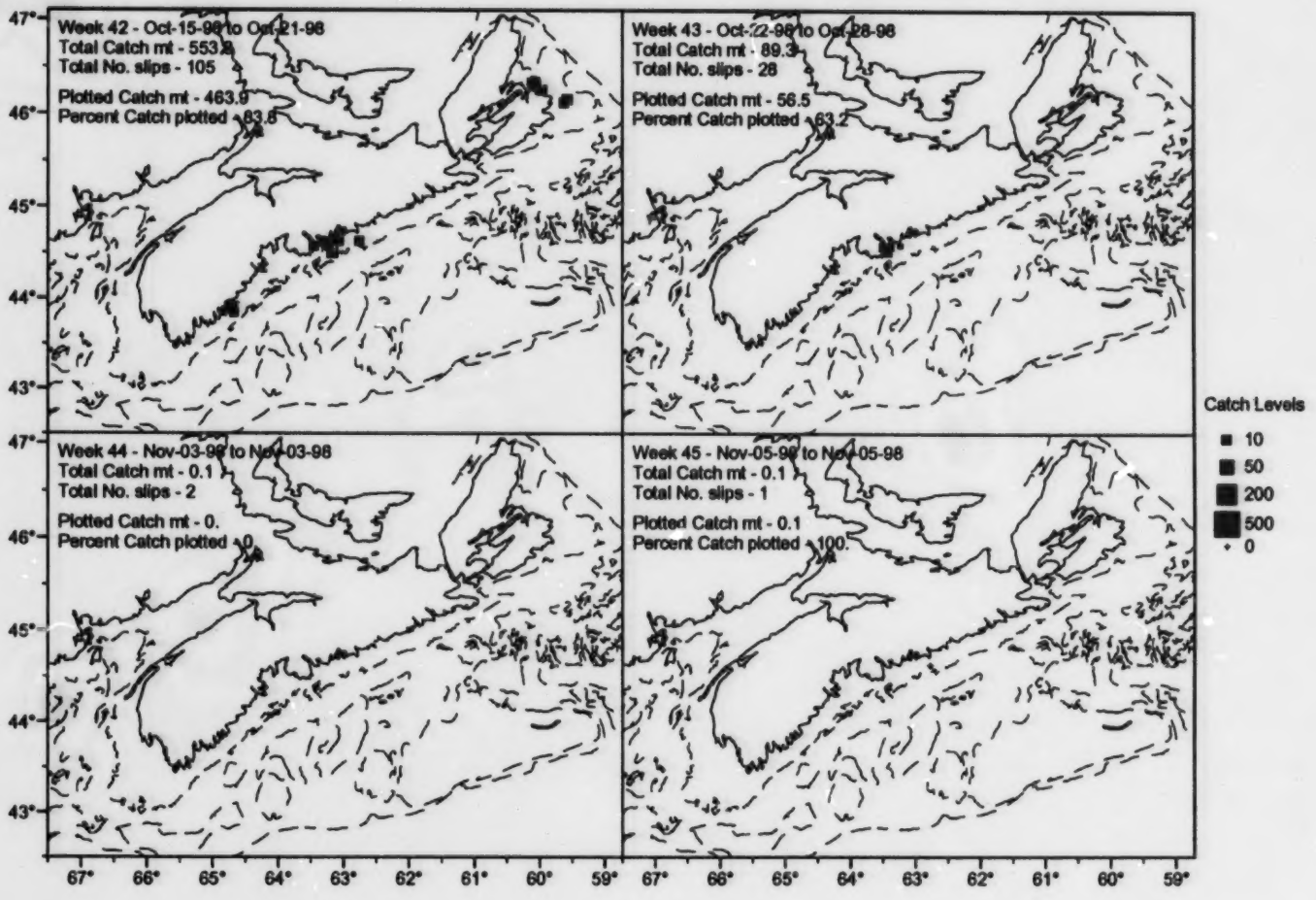

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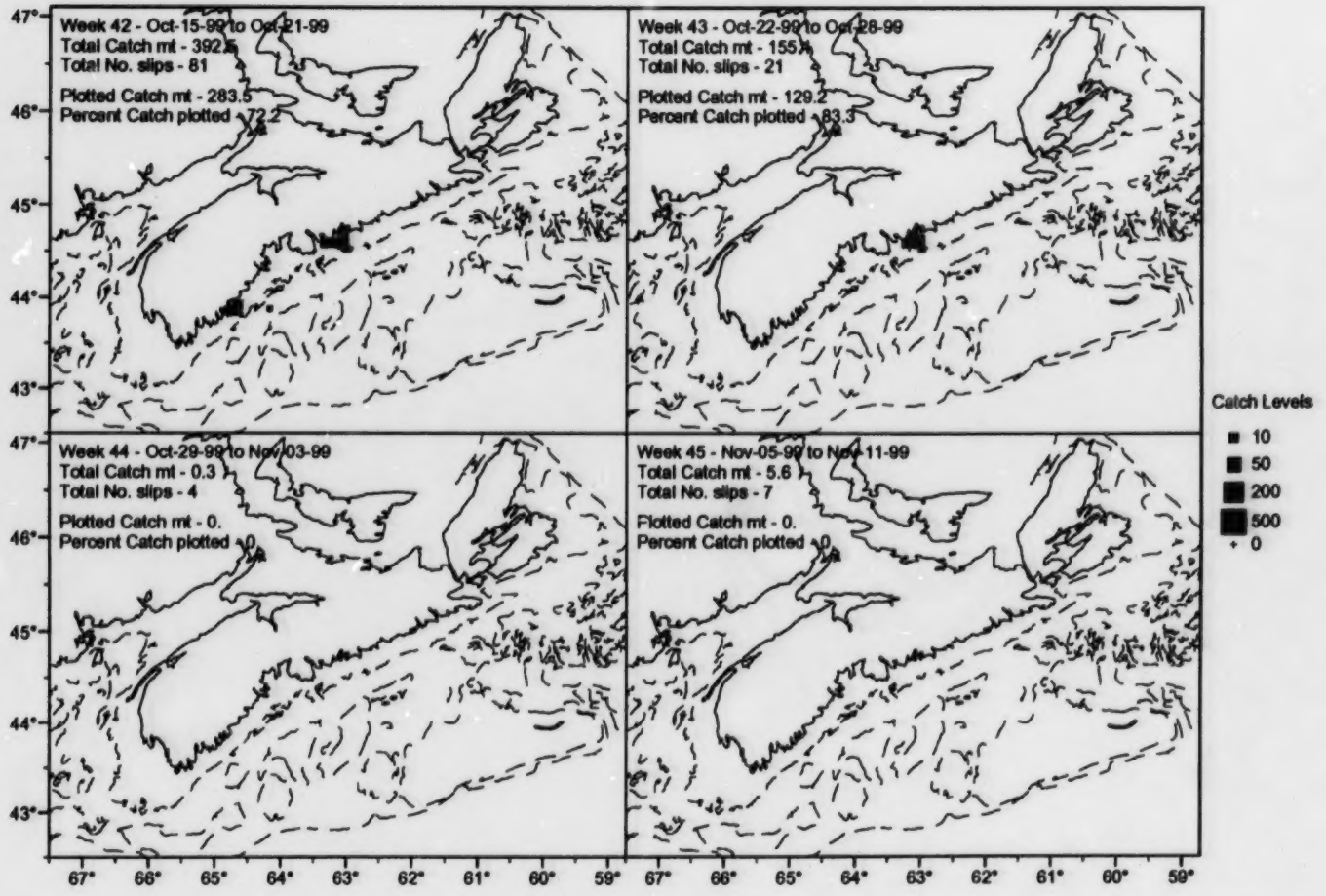
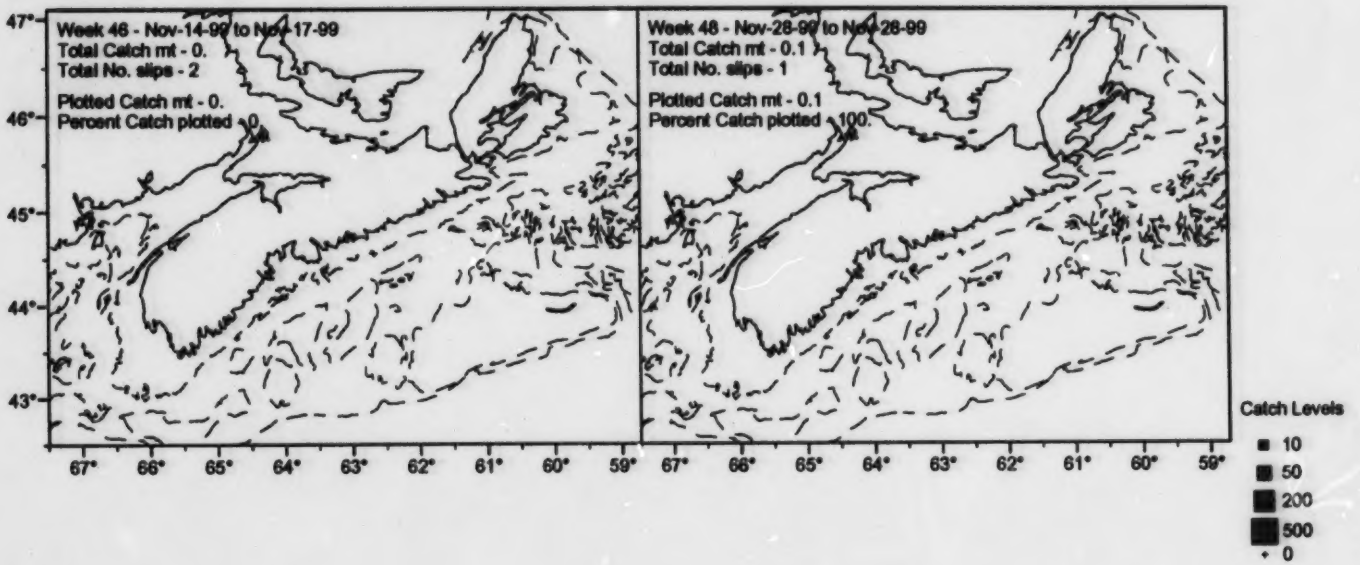


Figure 8. 4VWX herring gillnet catches by week for quota year Oct. 15, 1999 to Mar. 1, 2000. (by 1 mi. boxes).



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